Engineering News

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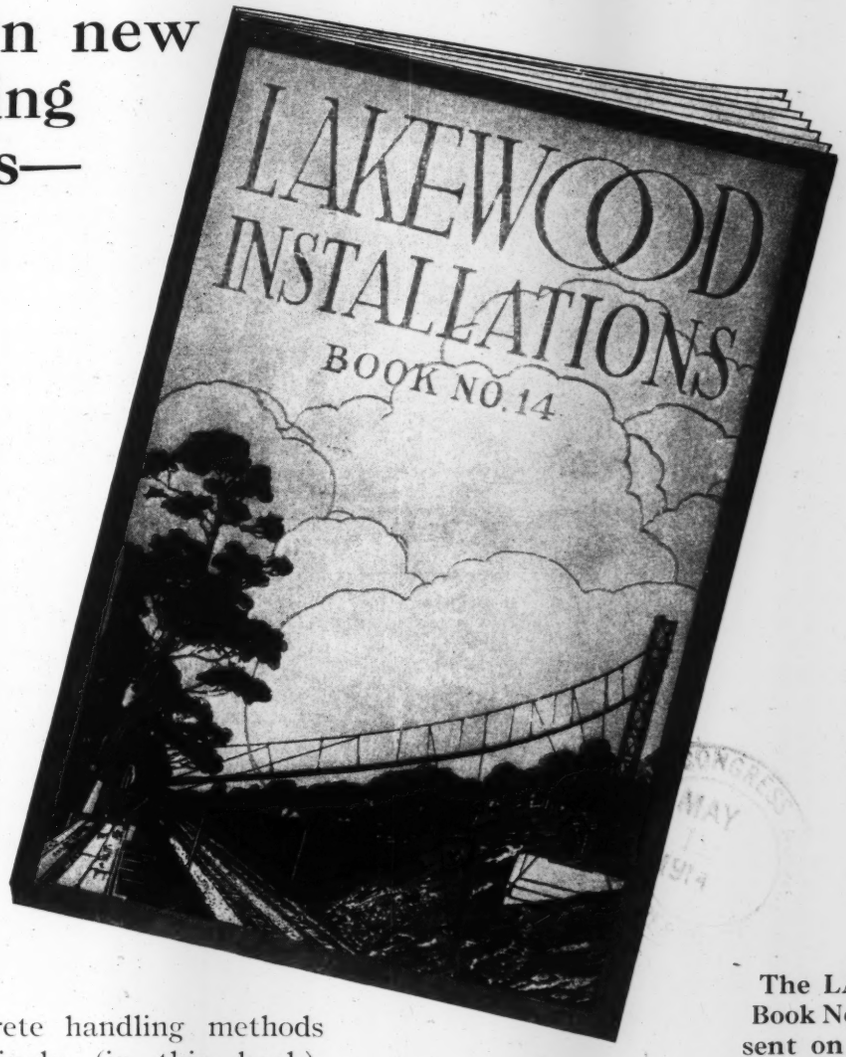

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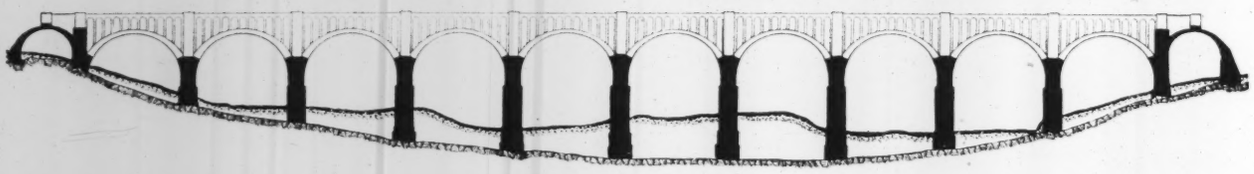

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Engineering News

CHARLES WHITING BAKER, *Editor*

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Engineering News

VOLUME 71 MAY 7, 1914 NUMBER 19

Breaking a Heavy Ice Jam in the Great Miami River

By Paul D. Fuqua*

An unusual ice jam formed above a temporary pile-trestle bridge which serves to carry High St. and the Ohio Electric Ry. over the Great Miami River, at Hamilton, Ohio, during the latter part of February. The river had been frozen over above the bridge for several days preceding the formation of the jam, but no trouble was anticipated by the County Commissioners of Butler County, who had built the bridge and had charge of its maintenance. The river here is about 420 ft. wide and at this time ranged in depth from 6 to 20 ft., with an average depth of about 14 ft.

On the night of Wednesday, Feb. 18, a slight rise in the river brought down considerable loose ice, and on the morning of the 19th, one pile in each of two adjacent bents on the upstream side of the bridge was snapped off and the top of the bridge was thrown as much as one foot out of line. The jam had formed for some 1200 ft. above the bridge, at which point the elevation of the surface of the water was found to be 2½ ft. higher than below the bridge where the river was clear of ice.

On the morning of Feb. 19, the County Commissioners closed the bridge to traffic and employed dynamiters to shoot out openings between the bents of the bridge in order to relieve the pressure due to heading up of the water. These men finally succeeded in removing the ice under the bridge from between two or three sets of bents, which lowered the head of water to about 1½ ft.

Ice Jam above High St. Bridge, Hamilton, Ohio

(The locomotive crane on the bridge is equipped with a pile hammer for breaking up the ice.)

On the afternoon of Feb. 19, a small locomotive crane was rented from a local contractor. A 2000-lb. pile hammer was hung on the fall line of the crane which was then run out on the bridge over the electric-railway tracks. This tool was of great assistance in breaking up the jam which in places was solid to the bed of the stream. By swinging the hammer back and forth in the water after the ice had been broken up as far as the hammer would reach, the loose ice was kept agitated and was forced between the bents and through the bridge.

A very good idea of the appearance of the jam and of the method of using the crane to break it up can be gained by referring to the accompanying view.

*Morgan Enginering Co., Dayton, Ohio.

There was considerable difference of opinion among those responsible for the work as to the safest and best method of breaking up the ice jam and ice field which was forming upstream above the jam. The quickest method of passing the ice through the bridge would probably have been to have the crane travel from one bank of the river to the other and break up the jam as far as it could reach all the way across, and have the dynamiters follow behind the crane, shooting off the lower end of the jam and working upstream from the bridge. Had this course been adopted and a second rise come in the river after the lower end of the jam had been broken up from bank to bank along the upper side of the bridge, no doubt the whole field would have become loosened, and the bridge carried out by the impact of the ice.

The plan adopted was to begin in the channel on the east bank of the river and shoot out the ice from between four sets of bents. A channel above this opening was then extended upstream by dynamiting. When the V-shaped channel had been opened up for about 200 ft. above the bridge, another opening between bents of the trestle was shot out and the work of extending the open channel upstream was continued until the upper end of the jam had been reached, which occurmred on the afternoon of Feb. 21. At this time the open channel which had been shot out, lay in the shape of a "V"—220 ft. wide at the bridge and extending some 1200 ft. upstream to a point at the upper end of the jam.

Sunday, Feb. 22, opened very warm. At noon, the ice was quite rotten and easily broken loose by the dynamiters. By putting off four or five shots at a time, they were successful in sending down the ice in large fields. At the bridge the hammer was kept swinging back and forth to break up the ice before it should strike against the piling and about 10 laborers were kept busy under the bridge with pike poles to guide the ice between bents and through the bridge.

Great progress was made on Sunday. By 5 p.m., the river above the bridge had been cleared of ice with the exception of one patch near the west bank which was grounded on a gravel bar and which, on account of eddy water at this point, was not considered dangerous. The thermometer fell to about 10° on Sunday afternoon, followed Monday by a blizzard. Practically the entire Miami River was frozen over during the next few days, which stopped the movement of floating ice. When the ice from this freeze began to go out, laborers with pike poles were stationed at the bridge to guide the ice through, thus preventing another jam.

The primary cause of the starting of the jam was the presence of a line of 2x10-in. horizontal longitudinal bracing, for the full length of the bridge, on both the upper and lower sides. This bracing was located at about the elevation of the surface of the water when the jam started. The jam after being fully formed, covered an area of about 12 acres and had an average thickness of probably six feet with a maximum thickness of possibly 16 ft.

Considerable scour occurred in the bottom of the river between those bents which were first opened. Accurate data are not available to determine the amount of scour which occurred at this time, but by comparing a cross-section of the river taken after the jam, with the cross-section taken when the bridge was built, it was estimated that the bottom had been cut out 4 to 5 ft. at the bents which were first opened up.

About 1500 lb. of 40% dynamite was used on the four days during which ice threatened the bridge. It was prepared in a shanty adjacent to the bridge and carried out in bundles to the men on the ice. Two sticks to the shot were generally used, only one of which was primed with cap and fuse. Early in the fight it was found that dynamite exploded on the surface of the ice was practically wasted, and that comparatively deep shots were more effective than shallow ones. In the shanty, the dynamite was made up for use by securely tying the sticks to one end of an ordinary 4-ft. building lath. On the ice, the firing squad drilled the holes four to five feet deep with pike poles and when they were all ready, tighted the fuses and pushed the lath as far down in the ice as possible. It was also found that by taking advantage of the current in the river to remove the ice which had been shot loose, assisted by a few men with pike poles, much better progress could be made than by shooting in dead water.

The cost of the work of removing the ice jam, and of putting the bridge back in good condition afterwards was about $1800. The original cost of the bridge was approximately $11,000. The work was done under the direction of the County Commissioners of Butler County, with Fred M. Hammerle as County Engineer.

An Ocean Viaduct in India with a Rolling-Lift Draw Span

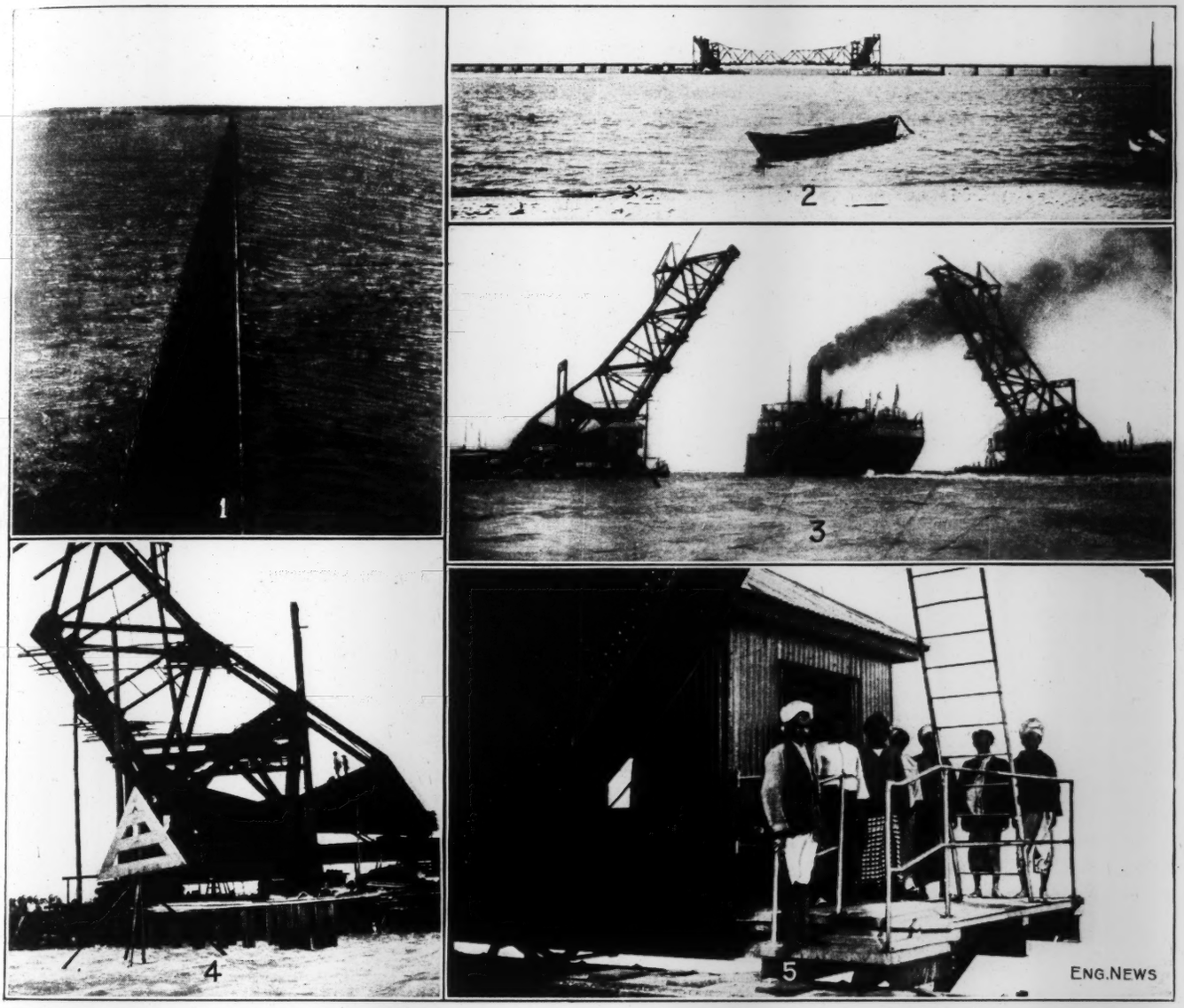
The first link in a through railway connection between the south end of the Indian peninsula and the Island of Ceylon was completed when the Pamban channel viaduct was formally opened on Feb. 24, 1914. The viaduct is 6776 ft. long and extends from Tonitural, in India, to Pamban, on the Island of Rameswaram. The railway is continued across the island to newly built piers at Danishkodi, where passengers and freight will take steamer for a 22-mile trip across the strait known as Adam's Bridge to the Island of Manar, to which point the Ceylon railway system has been extended.

The connection of the island to the mainland has been projected for many years but has been postponed on account of the excessive cost; the new system is a step toward the complete rail connection but the crossing of Adam's Bridge is left for the future. The recent construction, however, substitutes a continuous railway run, with an intermediate one-hour ferry, for the old dangerous and tiresome ship passage from Tuticotrin to Colombo, a distance of 150 miles.

The Pamban Viaduct consists of 145 plate-girder spans, varying from 40 to 44 ft., and an intermediate Scherzer rolling-lift draw span of 289 ft. clear opening. The piers for the girder spans are of granite masonry in cement mortar, with concrete footings inclosed in steel cylinders founded on hard calcareous sandstone. The reef consists of large blocks partly above water, resting on softer sandstone on a stratum of compact sand. Though the reef is partly awash, in some places the depth of water even at low tide is as much as 6 ft., the tidal variation being about 3 ft.

Erection of Draw Span

The Scherzer Rolling Lift Bridge Co. have forwarded to us the following account of the erection of the draw span, a unique piece of work, owing to the primitive labor and machinery available.



FIGS. 1-5. VIEWS ON THE NEW VIADUCT LINKING INDIA TO CEYLON

Fig. 1. Looking over the viaduct toward India from the top of the lift span. Fig. 2. The draw span with adjacent spans of the viaduct. Fig. 3. The span raised. Fig. 4. Erecting one leaf of the draw span. Fig. 5. Operator's house and some of the motive power.

The substructure for the Scherzer bridge consists of two 9-ft. diameter and two 12-ft. diameter cylindrical piers at each side of the channel. The cylinders of ¾-in. steel plate with bolted water-tight joints are in sections, extending down about 45 ft. below mean sea level into a stratum of stiff yellow clay, and are filled with concrete. The cylinders on the Pamban side were sunk with an air lock but those on the Toniturai side were sunk by dredge and divers. To facilitate the sinking of these cylinders an artificial island, on each side, about 60 ft. square, was made of coral boulders and concrete in sacks inclosed within a timber crib and covered with clay and sand.

The erection of the Scherzer bridge was carried out solely by native Indian labor, and to prevent interference with navigation the leaves were erected in a position inclined about 60° to the horizontal with high wind and strong current prevailing. The bridge is of the double-leaf, through type, for single track of 3 ft. 3⅜-in. gage, with a span of 225 ft. between bearings, and a width of 20 ft. between center lines of trusses. The two leaves are hand operated and can be opened to an inclination of about 82°.

The erectors were Moplahs, who are natives of Malabar Coast on the western side of India. They were employed by two contractors, Abdulla Kooty and Chinna Bawa, each of whom had been awarded the erection contract for one leaf and had previously erected the 40-ft. girder spans. This division of the work necessitated two sets of erection plant and equipment, but the rivalry created (although not exactly friendly at times), did much toward expediting completion of the bridge. The Moplahs did not have much previous experience of bridge erection, but were strong and active and skillful in rigging work. All other labor was employed directly by the South Indian Ry. Co., and was composed mainly of Anglo-Indians (Eurasians) and Tamils as foremen, enginemen, mechanics, rivet inspectors, painters and boatmen, in addition to the coolies of both sexes.

The Scherzer bridge material, shipped from England, arrived in July, 1913, and was transferred about two miles from the shore to pontoons and lighters or native

boats. The pontoons and lighters were towed by a launch or poled by Indian boatmen to Toniturai, where the material was unloaded and stored with the exception of the track girders and segmental girders and the anchorage columns, which were taken directly to the artificial islands at the bridge site.

The average hours of work were about ten per day, and work was carried on continuously, on Sundays as well. Erection work commenced on July 20, 1913, with the drilling of holes in the anchorages for the anchorage column splices. The anchorages, about 36 ft. long, had been embedded 30 ft. in the concrete of the 9-ft. cylindrical piers, during construction of the substructure. The 12-ton track girders were then moved and hoisted into place by means of tackle and hand winches and a gantry or framework of teak poles lashed together, on each island which had been left standing after being used on the substructure work.

Erection of the fixed portions for each leaf proceeded, the anchorage columns being placed, and subsequent material was brought to the islands as needed. Because of the small space on the islands, only a few pieces could be brought at a time from the store yard at Toniturai There the pieces required were marked and workmen sent from each of the erection gangs, loaded them on flat cars with the assistance of a 10-ton railway crane. The materials for each half of both leaves had been painted a distinctive color in addition to the erection marks, so the most illiterate of the workmen could distinguish them. The cars were moved to a pier at Ramen Point and transferred by another 10-ton crane to pontoons or lighters, which were poled out to the islands at the bridge site.

Riveting was performed by pneumatic tools, as well as the drilling and reaming necessary, for which a steam-driven compressor plant was installed on each island. Coal and water for the compressor engines and other supplies were brought to the islands by boats. The riveting done was a source of annoyance at first, due to the inexperience of the workmen, but as the work progressed the riveting improved. The workmen soon acquired experience and were able to drive good rivets at a rate of 250 a day per squad.

When the fixed portions of the bridge had been erected and the segmental girders and some of the subsequent pieces placed and blocked up in their proper positions, the gantry poles for erecting were removed and the counterweight boxes assembled. Riveting followed closely on erection, and after completion of the counterweight boxes, forms of ⅝-in. teak wood for the adjustment pockets were put into place in the boxes by Indian carpenters from the construction workshop at Toniturai. Although these carpenters, like the other Indian workmen, use tools and methods that do not wholly conform with American and European ideas and had little knowledge of plans, their work was good. In one respect, they have the advantage of being adepts in supplementing their handicraft with their footcraft. Stacks or cribs of old railway ties were placed to support the counterweight wings during the unbalanced condition of the leaves, and runways were built for placing the counterweight concrete. The work of mixing and placing concrete for the counterweight followed. A machine mixer of ½ cu.yd. capacity mounted on a pontoon scow moored at each island was used, the concrete materials being brought alongside on other scows.

As the batches of concrete were mixed, they were dumped upon the deck of the scow and shoveled into galvanized-iron dishes about 12 in. diameter and 5 in. deep. The concrete was carried up the runways in these dishes by the coolies comprising young boys and women of all ages, and passed along to be deposited in the counterweight. In this way as much as 2 cu.yd. per hour could be placed. While the concreting was going on, the erection and riveting were also progressing. Two panel lengths of top chords for each truss, the adjacent web members and the machinery floor and bracing for each leaf were in place, when an erection derrick was assembled to rest on the top chords of the second panel.

By means of these erection derricks the web members, chords, floor and bracing members were hoisted up and bolted in place in logical sequence. The jibs of the derricks were 30 ft. long, so that the erection could be done one panel length ahead of the derricks. The derricks were moved up along the top chords one panel at a time as the erection progressed, by means of blocks and tackle attached to the top chords, and then securely lashed in place. The hoisting was done with the hand winches down on the islands and the jibs were swung up or down with hand winches on the derrick platforms.

Erection was interfered with to some extent by the strong winds, especially about the middle of October, when the southeast monsoon was concluding with a final blow. The southwest monsoon commenced in May and concluded in October, when the wind alternated between southwest and northeast with intervals of calm, until the northeast monsoon set in late in October, with occasional storms and an average daily rainfall of about two inches. Notwithstanding the weather conditions, the erection and greater portions of the riveting were completed and the operating machinery was set, so that the west leaf of the bridge was operated to the closed position for the first time on Nov. 15 and the east leaf three days later.

After the slight adjustment in alignment of the two leaves had been done and the bracing riveted, track materials were laid. While this work was being done, the bridge was kept in the closed position. The work had to be carried on with a view to the necessity for opening the bridge for navigation whenever a ship was sighted. Usually, at least one ship per day passed, but no interruption to navigation occurred.

Much delay was caused, not only on the bridge construction but on other construction work of the Indo-Ceylon connection by four days of stormy weather at the end of November. Many miles of railway embankment on the Island of Rameswaram were damaged, as were the islands at the bridge site, though the bridge showed no effect of the storms. On the east island, sheet piling and top filling were washed away, so that only half of the island remained above water, and the compressor plant had to be removed. The damage on the west island was not so great, but the compressor and boiler had to be moved because of settlement.

The first train across the bridge was run through on Dec. 14. The final adjusting and riveting were completed at about this time by the Moplahs, the laying of track material as well as the setting of the operating machinery and building of the operators' houses being performed by departmental labor of the railway company. Several trains per day were thereafter run over the bridge to the island of Rameswaram, carrying ballast and materials for construction and for repairs caused by the storm.

The official inspection and approval of the bridge by the senior inspector of the government of India occurred on Dec. 29. On Jan. 1, 1914, regular passenger traffic across the bridge commenced. Thus through service from the main line of the South Indian Railway to Dhanushkodi was inaugurated, and the ferry service between Mandapan and Pamban was abolished, which had previously served the immense pilgrim traffic at times amounting to more than thirty thousand passengers per day.

PERSONNEL

Robert White, of London, was Consulting Engineer and H. P. O'Shaughnessy, Executive Engineer, on the entire work, acting for the South Indian Ry. Co. The steelwork, including the lift span, was fabricated by Head, Wrightson & Co., of England. The lift span was designed by the Scherzer Rolling Lift Bridge Co., Chicago, Ill., under the direction of Albert Scherzer, Chief Engineer, and R. L. Larson was Resident Engineer for the Scherzer company during erection.

A Train-Order Siding Signal Controlled by the Dispatcher

On double-track railways equipped with automatic block signals, it is often desirable to facilitate traffic by ordering a train to take a siding in order to let a following superior or faster train pass it, and it may be desirable to do this at some point where there is no operator. There is already in use in connection with telephone train dispatching a selector system employed for the selective calling of stations, and in order to meet the above requirement this system has been adapted to the control of special "take siding" signals located at the outlying switches of passing tracks.

This arrangement affords practically all the facilities of a train-order station, without the expense of the operators, as the dispatcher can cause the display of a "take siding" signal at any siding on his division so equipped, and can issue orders or other instructions to trainmen when they call up to report that the train is clear of the main track.

Among the signal exhibits at the recent Railway Appliances Exhibition, in Chicago (in connection with the convention of the American Railway Engineering Association) was a "take siding" signal having a rectangular target attached to the signal post, below the semaphore blade. To give the order, the words "take siding" appeared in illuminated letters. A semaphore, disk, light or other form of signal may be used, as desired. The signal is controlled by a key in the dispatcher's office, the two line wires of the selector and telephone circuit; and a selector mounted on or near each "take siding" signal. A local battery of potash cells supplies energy to operate the signal mechanism.

To display the "take siding" indication at a certain siding, the dispatcher turns the proper key, causing a series of electrical impulses to be transmitted to the line, thus operating the corresponding selector which closes a contact and completes a circuit from the local battery through the signal mechanism. The operation of the signal in being displayed or released causes the operation of a special "answer-back" device which produces an audible indication, informing the dispatcher that the signal has operated and that the proper indication is displayed.

Being installed in automatic block-signal territory, there is no reduction of safety, as the automatic signals provide against any danger that might result from misunderstanding of or failure to obey the signal The only effect would be that the faster train would have to continue behind the slower train. The cost of installing a "take-siding" signal in connection with a selector system is small and depends principally upon the type of signal used.

This new feature in signaling equipment is being introduced by the General Railway Signal Co., of Rochester, N. Y. The cost of installation is said to be small, only very simple equipment being required. This system can be adapted also to the usual train-order signals at stations, so as to notify a train crew to stop and call up the dispatcher for orders.

A Manganese-Bronze Casting for a 48-in. Water Valve

The accompanying view shows a 23,000-lb. manganese-bronze valve casting in the rough, cast and to be machined for the Board of Water Supply, New York City, by the Exeter Machine Works, Pittston, Penn. The total weight of the completed valve will be 30,000 lb. It is a 48-in. riser valve of which 25 are being made.

The same manufacturers are making six valves of this kind, 72 in. in diameter, of a total weight of 46,000 lb. each. For the whole order from the Board of Water Supply 1,000,000 lb. of manganese bronze will be required. The tensile strength of the castings runs as high as 75,000 lb. in many cases and of the forged rods to over 80,000 lb.

These valves are semiautomatic in their action and are called riser valves, because one is placed in each riser pipe in the shafts of the City Tunnel of the Catskill Aqueduct. They are the last means of shutting the water of the tunnel from the connections to the subsurface mains in the streets. At the top of each riser is a bronze shaft cap, or three-way branch casting, on the side outlets of which are bolted bronze gate valves. Beyond these bronze gate valves will be placed the usual cast-iron valves for the ordinary control of the flow of water from the tunnel to the service mains. In case of a large break in a street main, or other accident causing a very excessive flow through the riser, the increased velocity will cause the riser valve to close. The valve may also be closed manually from the chamber at the top of the shaft, or from a distant controlling apparatus. To prevent objectionable water-hammer in the pipe system or tunnels, the riser valve is prevented from closing too rapidly by means of a dashpot and piston which form an integral part of each riser valve.

New Shops for the Lima Locomotive Corporation

The works of the Lima Locomotive Corporation, at Lima, Ohio, occupy a triangular tract of land of about 42 acres, lying between the Cincinnati, Hamilton & Dayton R.R. and the Lake Erie & Western R.R. The plant formerly had a capacity of about 300 locomotives per year. The plant as now enlarged has a capacity of 900 locomotives per year. Additional land has been purchased, and new buildings erected, while changes have been made in the old buildings and the track layout. On the original part of the site there was constructed a new erecting shop, 142x385 ft., and a flange shop, 100x176 ft., the latter forming an extension of the boiler shop (120x 444 ft.), while a second riveting tower was added to the latter shop. On the additional property there were erected four new buildings: tank shop, 120x300 ft.; hammer shop, 100x202 ft.; smith shop, 100x242 ft.; and pattern shop, 60x160 ft. This last is of concrete, while all the others are of steel. There is also a steel building for the coal-pulverizing apparatus. Fig. 1 is a plan of the enlarged plant.

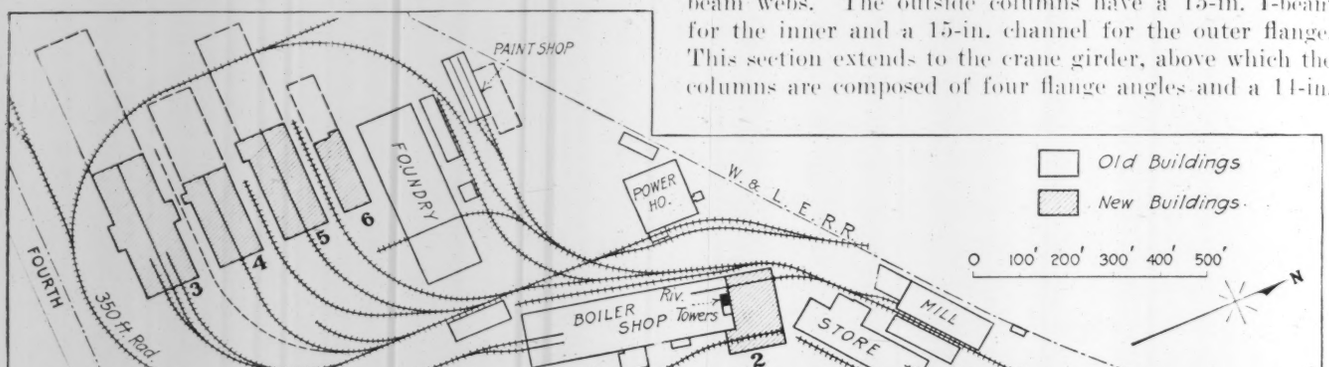


FIG. 1. PLAN OF THE SHOPS OF THE LIMA LOCOMOTIVE CORPORATION, AT LIMA, O.; SHOWING THE NEW BUILDINGS AND PROVISION FOR EXTENSIONS

STEEL ERECTION WORK

The steelwork conforms to the Manufacturers Standard Specifications. It was given two coats of graphite paint, one applied in the shop and the other after erection.

All steel erection was done with four traveling stiff-leg derricks of 50 tons hoisting capacity, carrying booms 100 ft. long. These were of steel construction and the booms were long enough to place the roof trusses and monitor roof framing. The book tile for the roof of the erecting shop were handled by a platform elevator in a timber tower at the middle of the building. This plant at work on the erecting shop is shown in Fig. 2. The steel gang numbered about 85 men. Work was commenced on Jan. 12 and completed Mar. 8, 1913. The tonnage and time of erection of the several steel buildings were as follows:

Building	Tons	Time of erection
Erecting shop	1200	26 days
Boiler shop	225	10 days
Smith shop	260	8 days
Hammer shop	253	6 days
Tank shop	300	7 days
Coal-pulverizing plant	20	10 days
Riveting tower	12	7 days

ERECTING SHOP

The design of the erecting shop is shown in the cross-section, Figs. 3 and 4; while Fig. 2 shows it partly erected, and Fig. 5 shows the completed framing of the erecting bay. The building is divided into two bays. The larger one, which is the erecting shop proper, is 80 ft. 3 in. wide c. to c. of columns and 50 ft. high to the bottom chord of the roof trusses. The smaller one, which is the machine shop, is 59 ft. 6 in. wide, and has an upper floor for the lighter tools. The headroom is 23 ft. 9 in. for the lower and 13 ft. 6 in. for the upper floor. On the outer side of this bay is a two-story wing about 20 ft. high, containing shop offices, blueprint rooms, etc. This is 10 ft. 6 in. wide and 239 ft. long, extending between two towers for elevators which serve the upper floor of the machine shop.

The columns of the main shop are of H-section, composed of two 15-in. I-beams, 32¼ in. apart, with a 32-in. web-plate riveted between the shorter legs of angles of 5x3½ in., the longer legs of which are riveted to the I-beam webs. The outside columns have a 15-in. I-beam for the inner and a 15-in. channel for the outer flange. This section extends to the crane girder, above which the columns are composed of four flange angles and a 14-in. web-plate. The outside columns of the machine-shop bay are of similar section to the height of the second floor, but with a 26-in. web-plate and two 12-in. channels in place of the I-beams. Above this level they are composed of four angles and a 14-in. plate.

The intermediate columns, supporting the second floor, are composed of two 12-in. I-beams placed close together, with 12-in. cover-plates riveted over the flanges. These columns support transverse 30-in. plate-girders, upon which is laid the reinforced-concrete floor slab, the slab being strengthened by longitudinal concrete beams between the girders. The carrying capacity of this floor is 400 lb. per sq.ft.

Each crane runway of the erecting-shop bay has an 80-lb. rail on an inverted 15-in. channel resting on the top flange of the runway girder. This girder has a web-plate 30x¾ in., tied to the columns by diaphragm plates. The crane runways in the machine-shop bay have 40-lb. rails on 24-in. I-beams, with 10-in. inverted channels on the two outer runways only. On the inner runways the rails rest directly upon the I-beams. The runway girders in this bay do not rest upon the columns, as in the erecting shop, but have their webs secured to the ends of pairs of 15-in. channels which are riveted across the

... of the columns. In the flange shop, Fig. 6, the ... runways are 20-in. I-beams resting on brackets on ... columns, and tied to the columns by diaphragm ...

The columns are spaced 20 ft. c. to c., longitudinally, and are connected by lines of trusses on the outside (Fig. 5), with sway bracing in some of the panels. The chords of these trusses are channels laid flat so as to form shelves for the sash frames and curtain walls. The roof trusses are connected by purlins of 10-in. channels across which are laid 2¼x2¼-in. T-bars, 18 in. apart. These carry the 3-in. book-tile roof covering, tile being adopted in preference to concrete as the work was done during the winter. This is covered with composition roofing.

The ordinary monitor roof construction is not used in any of the buildings. The erecting shop has a wide flat central skylight, with a 30-in. exhaust ventilator in each panel. The machine shop has a continuous butterfly monitor, with its top sloping upward from the center so that smoke will be guided out of the building instead of hanging in the monitor. This has the structural framing so arranged as not to interfere with the movement of the hinged sash, thus avoiding troublesome joints between the steel sash and the vertical members of the roof framing. A detail of this is shown in Fig. 3.

The walls are of concrete below the grade line, carrying 12-in. brick walls which rise to the level of the concrete window sills. Between the tiers of windows, the walls are of 2½-in. concrete on "hy-rib" metal. All floors are of concrete. The north end wall is of brick, and brick is used aslo for the office wing, and the elevator towers. The track entrances have vertically sliding wood doors, operated by hand and counterbalanced by weights on cables (Fig. 4).

The erecting-shop floor has four longitudinal tracks, two extending through the building and two terminating at the north end. This floor is served by two 75-ton electric traveling cranes, each having a 15-ton auxiliary hoist. The crane rails are 39 ft. 10 in. above the floor, and the clearance under the crane hooks is 37 ft. for the main hoist and 42 ft. for the auxiliary hoist. In the machine shop, each bay of the first floor is served by a 15-ton electric traveling crane, while the second floor is served by two electric elevators of 4000 lb. capacity, with a speed of 50 ft. per minute. These elevators are in towers on the outside of the wall of the building.

Flange Shop and Riveting Tower

The flange shop, 100x176 ft., is an extension of the old boiler shop (120x444 ft.) and its construction is very similar to that of the erecting shop. Its roof sheathing, however, is of 2-in. matched Norway pine instead of book tile. As shown in Fig. 6, the building is divided into two 50-ft. bays, each served by a 10-ton electric traveling crane, the height from the floor being 23 ft. to the crane rails and 24 ft. to the hoisting hook. The roof of each bay has a butterfly monitor with inclined continuous steel sash, as in the machine shop. A wing 20x50 ft. is built along the side of the boiler shop to accommodate the hydraulic accumulator serving the boiler-riveting machines.

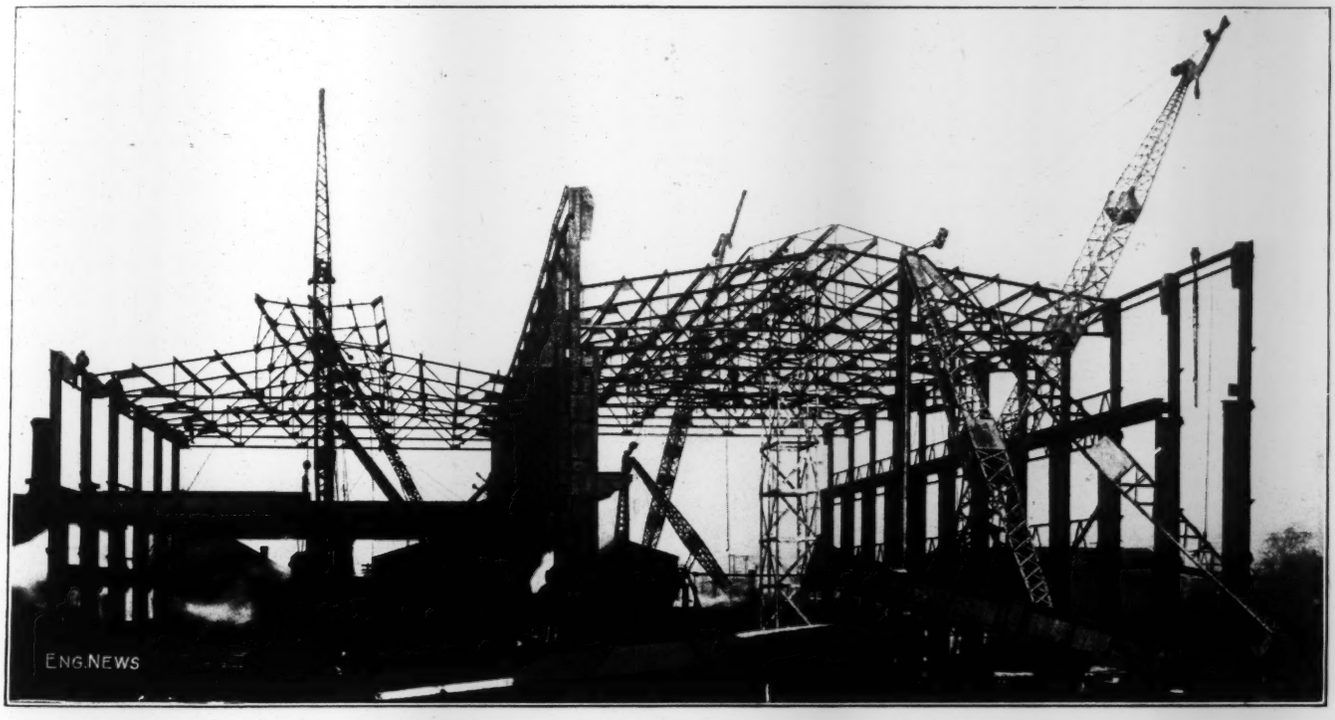


Fig. 2. Erection of the Steel Framing of the Erecting Shop
(Four traveling A-frame derricks with 100-ft. booms handled the steelwork. The elevator tower is for handling the book-tile of the roof covering.)

The original riveting tower was at the northeast corner of the boiler shop, occupying one bay at the north end, or a space 20x30 ft. The new tower is an exact duplicate of this in size and general arrangement (Fig. 1). Each tower is built to accommodate two 30-ton electric or hydraulic cranes, which handle the boilers during the riveting operation, before and after which they are handled by the 30-ton traveling crane in the main part of the building.

The riveting towers are supported at the north end by the brick wall of the old building, and at the south end

on the first transverse roof truss. To provide for the additional weight of the new tower it was necessary to reinforce this roof truss and the columns supporting it. The truss is of the Fink type. The secondary members, however, do not receive any of the riveting-tower load, which is carried entirely at the peak of the truss. It was thus a comparatively simple matter to reinforce the truss, which was done by placing two 12-in. 25-lb. channels horizontally on both top and bottom chords and riveting them to the chords. Double sets of gusset plates were then provided at the peak and ends of the truss, being connected to the flanges of the channels.

The same type of reinforcement was carried out for the columns supporting the truss, the reinforcing channels being carried down about 2 ft. below the crane girder in the main part of the building. The lower parts of the columns were found to be sufficiently strong for the additional load without any reinforcement. The gusset plates at the ends of the truss were carried over and riveted to the reinforcing channels of the columns. This construction is shown in Fig. 6.

At the north wall the greater part of the load is carried by the center pier, and this is reinforced by a pilaster on the inside which, however, was added after the building was first built. It was, therefore, deemed necessary to reinforce this pilaster. This was done by constructing a U-shaped concrete pilaster around the brick pilaster, and bolting it through both the latter and the wall. Considerable difficulty was experienced in providing an adequate footing for the pilaster, on account of the proximity of various riveting machines, etc. This difficulty was increased by the necessity of underpinning the adjacent parts of the north wall in order to provide for present and future machinery foundations. This was finally accomplished without interfering with the old riveting-tower operations.

The foundation immediately under the pilaster was first excavated. A brick footing course was built at the new elevation, and the pilaster was then supported by gas-pipe columns set on this footing. The concrete footing was then built over the brick footing, and the completed pilaster was built on this.

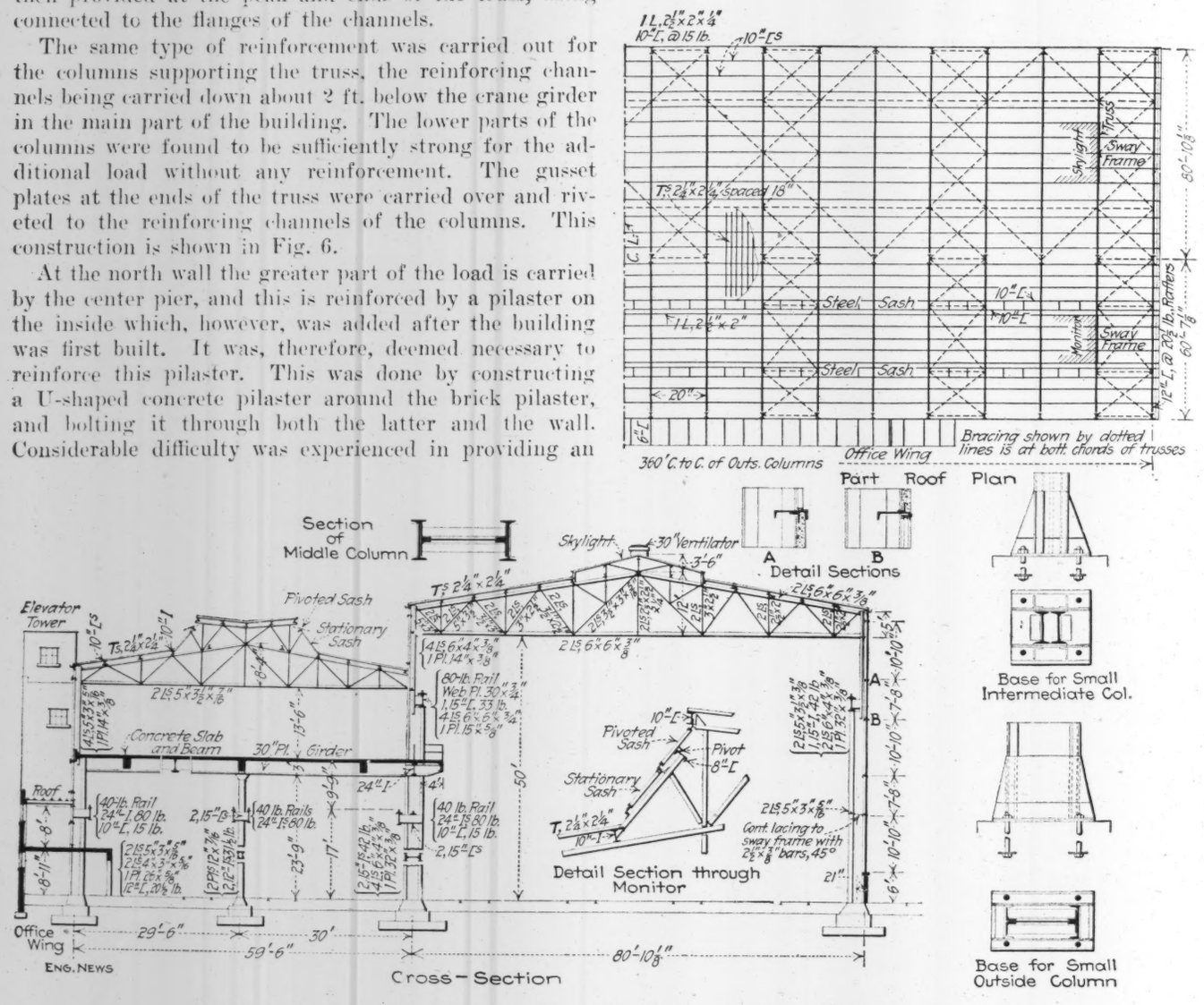

Part Roof Plan
Bracing shown by dotted lines is at bott. chords of trusses
360' C. to C. of Outs. Columns
Office Wing
Section of Middle Column
Detail Sections
Base for Small Intermediate Col.
Base for Small Outside Column
Detail Section through Monitor
Cross-Section
Office Wing
ENG. NEWS

FIG. 3. CROSS-SECTION AND ROOF PLAN OF THE NEW ERECTING SHOP

SMITH, HAMMER AND TANK SHOPS

These three new buildings are in a row on the new part of the property. A runway for a 10-ton electric yard crane extends along the east front of the buildings and to the property line, a distance of about 715 ft. The width between rails is 95 ft., and the height from the ground to the crane rails is from 21½ to 26½ ft. The exterior columns of the three buildings are designed to carry runways for lateral yard cranes, and are extended up above the roof to the desired height, as shown in Fig. 7, but the runway girders have not been placed, as the cranes are not yet required.

SMITH SHOP—This is a one-story building, 100x242 ft., having a central bay 70 ft. wide and two 15-ft. side bays. The roof trusses and exterior columns are spaced 20 ft. apart and the roof has a monitor of the type described above. The interior columns, however, are spaced 40 ft. apart (Fig. 8), in order to allow ample room for the 2-ton revolving jib cranes (of 20-ft. radius) which serve the furnaces in the side bays. Each interior column carries one of these cranes, and no overhead traveling crane is provided. A cinder floor is used, which is built up with the cinders coming from the furnaces. At one

corner is a wing, 13x47 ft., for the toilet and locker rooms.

HAMMER SHOP—This is of the same cross-section, but is only 202 ft. long. Its interior columns are spaced 20 ft. apart, instead of 40 ft., and are designed to carry 5-ton (instead of 2-ton) revolving jib cranes, the radius of which is 15 ft. Like the smith shop it has a wing for toilet and locker rooms, with a cinder floor for the shop and concrete floor for the wing. In one corner are two boilers for heating the tank shop and pattern shop. The butterfly monitor roof construction of these buildings is shown in detail in Fig. 7.

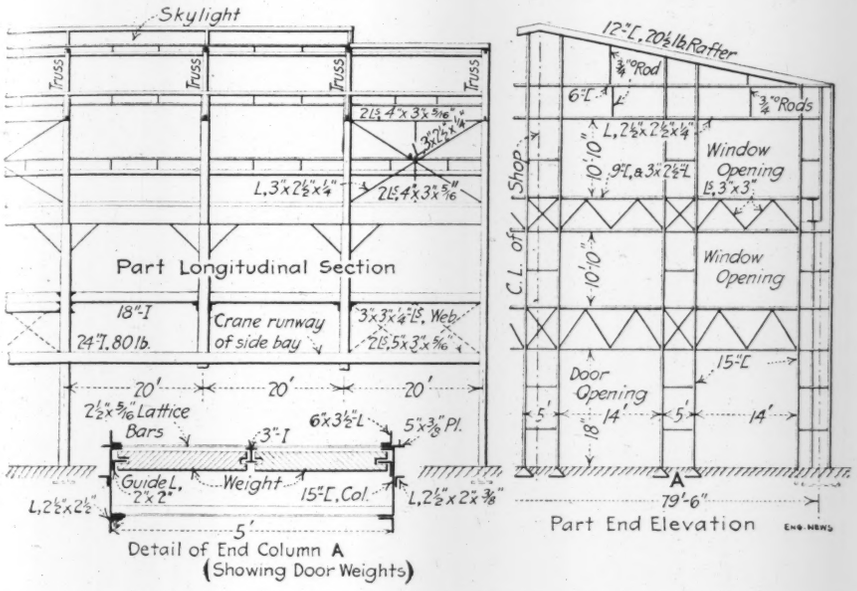


FIG. 4. ELEVATIONS OF FRAMING OF ERECTING SHOP

TANK SHOP—This is 120x300 ft., divided into a central 60-ft. bay and two 30-ft. side bays. There are no monitor roofs; but the central bay rises 12 ft. above the others, and has an 18-ft. skylight along the center. The floor is of concrete. The central bay is served by two 20-ton electric traveling cranes, with a clear height of 26 ft. to the hook of the main hoist and 27 ft. to that of the 5-ton auxiliary hoist. Each side bay has 5-ton electric hand cranes traveling on rails 14 ft. above the floor.

On the south side is a one-story wing 14½x61½ ft., used as a bolt room. On the north side is a two-story wing, the lower floor of which (13½x77 ft.) is occupied by the shop office, boiler room and locker room. The upper floor, 13½x50 ft., is the fan room for the heating plant. This has an 8½-in. floor of reinforced concrete supported by a brick wall on the outside, and by a line of 18-in. 55-lb. I-beams on the inside.

PATTERN SHOP

This building is a reinforced-concrete structure, 60x160 ft., three stories high. It has concrete columns, floors and roof, and brick spandrel walls, with steel sash frames. The first floor is used as the woodworking shop and the two upper floors for pattern storage. The second floor is of girder, beam and slab construction, while the third is of girder and cantilever slab construction. All floors are finished in concrete. This building has a 4000-lb. electric elevator, running at 50 ft. per minute.

SHOP-HEATING SYSTEM

The heating for the erecting, flange and tank shops is by the blower system, with the air recirculated. The pattern shop and the offices, toilets and other minor rooms in the remaining buildings are heated by direct radiation. All blower systems are based on a temperature of 60° F. with an outside temperature of 10° F. The main parts of the smith and hammer shops are not provided with heat. The steam for heating the erecting shop and the flange shop is supplied from the power plant. The steam for the pattern shop and tank shop is provided by boilers placed in the new hammer shop.

ERECTING SHOP—The erecting shop, with the two floors of tool bays at the side, presented a rather difficult problem in heating due to the height of the erecting room (60 ft.) and the fact that this room must be kept clear to permit operating traveling cranes the full length. The cubic contents and exposed surfaces are as follows:

1. Erecting shop, 1,878,000 cu.ft., 2580 sq.ft. of 8-in. brick wall, 42,300 sq.ft. of cement plaster on metal lath, and 22,700 sq.ft. of glass. 2. First floor of tool bay, 628,000 cu.ft., 2980 sq.ft. of 8-in. brick wall, 2490 sq.ft. of cement-plaster wall, and 8715 sq. ft. of glass. 3. Second floor of tool bay 470,800 cu.ft., 27,600 sq.ft. of cement-plaster wall and 7220 sq.ft. of glass surface. The total heat losses were taken as 4,379,000 B.t.u. for erecting shop, 1,246,000 B.t.u. for first floor of tool bay, and 1,843,000 B.t.u. for second floor of tool bay.

Two engine-driven double-inlet fans, each with a capacity of 75,000 cu.ft. of air per minute, are located on the second floor of the tool bay. The coils are of the

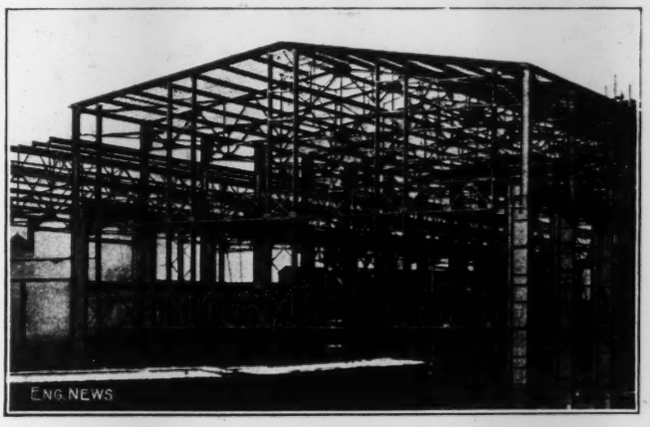


FIG. 5. COMPLETED STEEL FRAMING OF THE NEW ERECTING SHOP

blow-through type and were originally designed for 11,600 lin.ft. of 1-in. pipe each; but were changed to Vento cast-iron radiators of equivalent capacity in square feet.

The tool bays are heated by means of sheet-metal ducts located near the ceilings, provided with outlets fitted with dampers. For heating the erecting shop, a vertical sheet-metal flue is run down to the first floor, and then masonry ducts (under the floor) are extended the full length of the exposed wall. At approximately 20 ft. in-

tervals air is introduced at the floor through sheet-steel diffusers. The air is changed every 22 minutes in the erecting shop, every 28 minutes in the first floor of the tool bay and every 14 minutes in the second floor of the tool bay. All air is recirculated, and under maximum conditions the steam requirements are estimated at 250 boiler-horsepower.

TANK SHOP—This has an average height of 30 ft., with 1,188,000 cu.ft. contents, and exposure as follows: 4512 sq.ft. of 8-in. brick wall, 19,247 sq.ft. of glass, 10,890 sq.ft. of cement-plaster wall. The heat loss was taken at 3,902,000 B.t.u. with a resultant change of air every 17 minutes.

Two engine-driven fans with a total capacity of 80,000 cu.ft. per minute were used. The heating coils were designed for a total of 13,460 lin.ft. of 1-in. pipe, which were changed to radiators as above. Under maximum conditions 130 boiler horsepower will be required for heating. The fans are located near the first floor and the warmed air is introduced near the ceiling through a system of sheet-metal ducts.

FLANGE SHOP—The average height is 36 ft., with 648,000 cu.ft. contents. The heat loss was taken at 1,960,000 B.t.u., with a resultant air change of air every 21 minutes. The fan is located on the first floor, and has a capacity of 45,000 cu.ft. of air per minute. The air outlets are near the ceiling, through sheet-steel ducts.

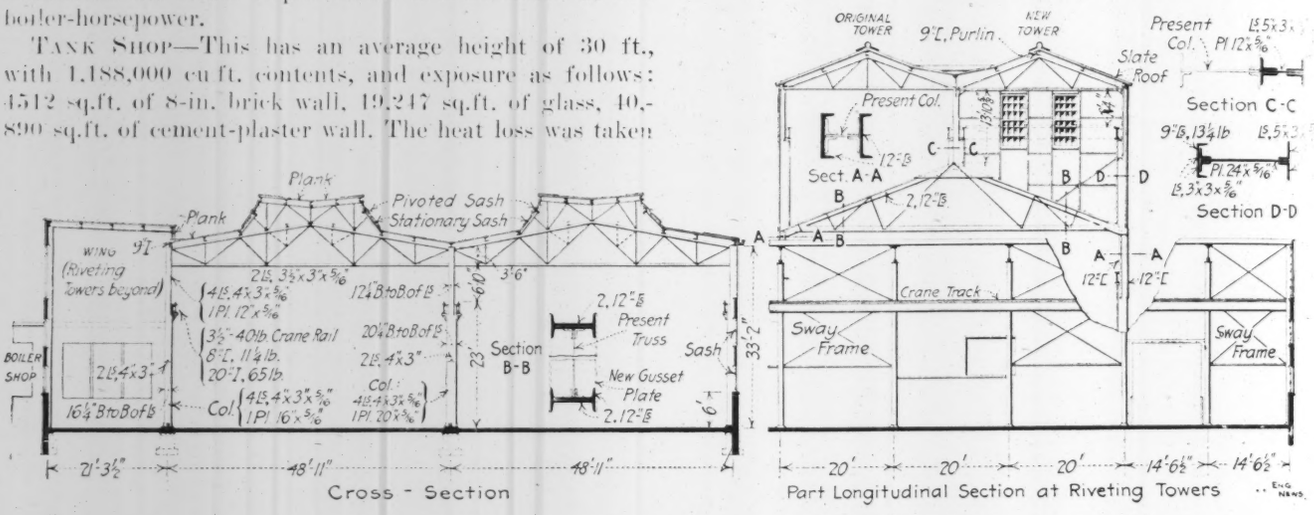


FIG. 6. FLANGE SHOP AND RIVETING TOWERS

DESIGNERS AND BUILDERS

The general and structural plans for the new buildings, together with the plumbing, fans, hot-water piping, steam heating and elevator equipment, were designed by the architect, Albert Kahn, of Detroit, with Ernest Wilby as associate. The electric lighting and the mechanical equipment were planned by G. L. Wall, Vice-President of the Lima Locomotive Corporation. The contract for all the steel buildings was let to the Worden-Allen Co., of Chicago, the work including the masonry, walls, roofing, etc., for the structures complete. The contract for the concrete pattern shop was let to the H. G. Spieker Co., of Toledo, Ohio. The work was inspected by H. C. Reely, representing the owners.

Tricked in Tricking the Water Meter Reader—Water consumers like other patrons of public utilities often get the notion that meter readers save themselves the trouble of reading the meters and put down some sort of guess for a reading. At the meeting of the Tri-States Water & Light Association of Georgia and the Carolinas on Apr. 17, 1911, Manager Smith of the Atlanta, Ga., Water Department told how a consumer who set out to catch a meter inspector fooled himself instead. This consumer reported that he had placed money and a note inside the meter-box cover, and that failure to remove these proved the meter had not been read prior to billing. An investigation showed that the inspector had read the meter, found the money and note, put a second note under the first one and left the two notes and money behind him. The consumer in this case was too quick in jumping at a conclusion.

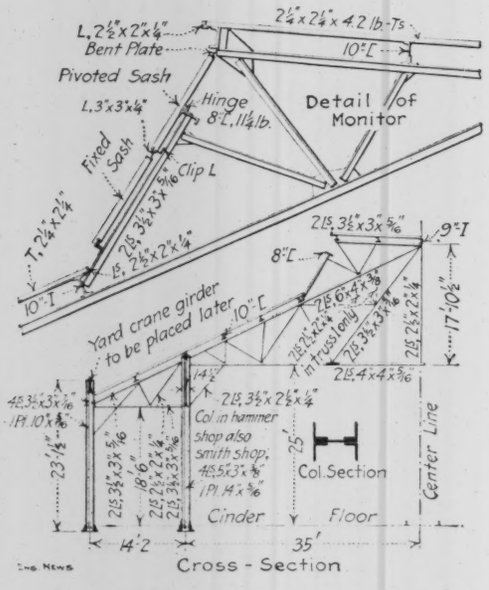


FIG. 7. HALF CROSS-SECTION OF HAMMER AND SMITH SHOP, WITH DETAIL OF BUTTERFLY MONITOR

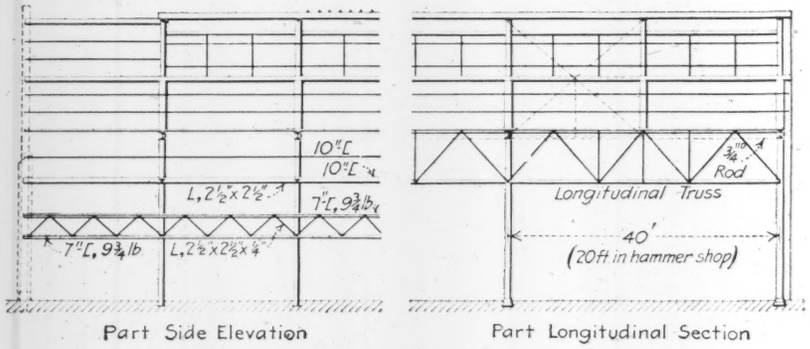


FIG. 8. FRAMING OF HAMMER SHOP AND SMITH SHOP

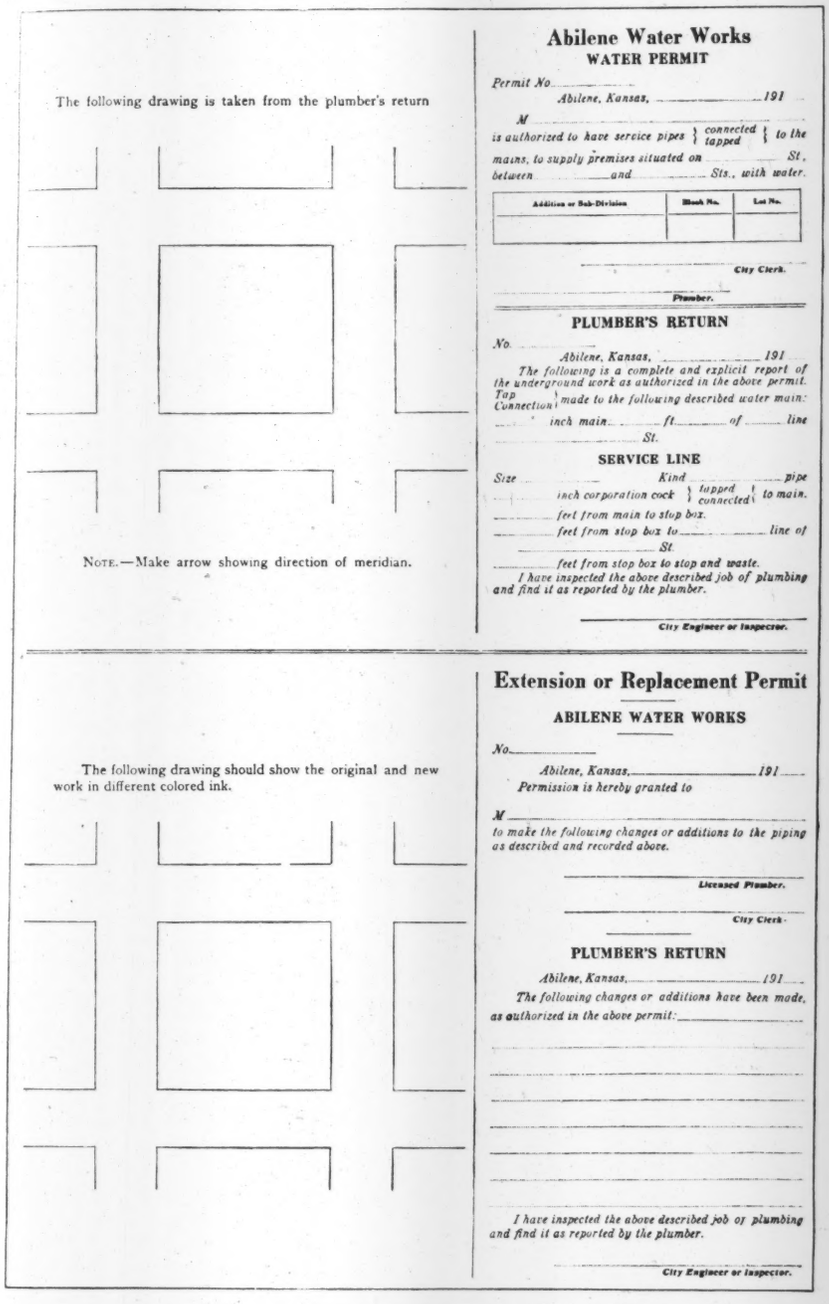
Records of Water-Works Mains and Services at Abilene, Kan.

By Kenyon Riddle*

There has recently been established in Abilene a recording system for water mains and services. The water-main records are made by the city engineering department and the private-service records by the plumbers.

Before describing the record system, it may be noted that before it was established it was not considered to be necessary to keep records of underground work in Abilene.

During the past year we have made an almost complete record of the underground water lines of Abilene, with almost no extra cost, above that of other work in hand.



The following drawing is taken from the plumber's return

NOTE.—Make arrow showing direction of meridian.

Abilene Water Works
WATER PERMIT

Permit No.....
Abilene, Kansas, ... 191

M.....
is authorized to have service pipes { connected / tapped } to the mains, to supply premises situated on ..... St., between ..... and ..... Sts., with water.

Addition or Sub-Division	Block No.	Lot No.

City Clerk.

Plumber.

PLUMBER'S RETURN

No.....
Abilene, Kansas, ... 191

The following is a complete and explicit report of the underground work as authorized in the above permit.

Tap Connection } made to the following described water main:

..... inch main ..... ft. ..... of ..... line ..... St.

SERVICE LINE

Size ..... Kind ..... pipe

..... inch corporation cock { tapped / connected } to main.

..... feet from main to stop box.

..... feet from stop box to ..... line of ..... St.

..... feet from stop box to stop and waste.

I have inspected the above described job of plumbing and find it as reported by the plumber.

City Engineer or Inspector.

The following drawing should show the original and new work in different colored ink.

Extension or Replacement Permit

ABILENE WATER WORKS

No.....
Abilene, Kansas, ... 191

Permission is hereby granted to

M.....
to make the following changes or additions to the piping as described and recorded above.

Licensed Plumber.

City Clerk.

PLUMBER'S RETURN

Abilene, Kansas, ... 191

The following changes or additions have been made, as authorized in the above permit:.....

I have inspected the above described job of plumbing and find it as reported by the plumber.

City Engineer or Inspector.

HOUSE-SERVICE PERMITS, ABILENE WATER-WORKS

WATER MAINS—Whenever a new main is laid all useful information regarding it is recorded. To obtain information on existing mains, not already recorded, every employee of the engineering department of the city takes and turns in notes on such mains whenever he has opportunity to do so.

The system of records consists of a large index map. This map is a blue-line print with all the mains, hydrants and valves drawn in with colored ink. It is divided into 40 districts which serve as an index to a more specific record of the mains and specials.

This detailed record is in book form. The book consists of 40 pages. Each page is an enlarged drawing of the corresponding district on the index map. It contains a complete and specific record of the work, giving the size of the main, its location with reference to street lines, its elevation, kind of pipe, date of installation, location of valves and the direction of turning them off, and any other data of importance.

HOUSE SERVICES—The accompanying forms and diagrams show our records of the services or private lines. These blanks are filled out by the plumber who puts in the line. Also, these blanks are arranged to care for all replacements and extensions. Besides obtaining a record of private lines, it will be noticed that a brief history of the main is also secured.

The large map already mentioned serves as an index to the records of private lines. Along the mains are given the permit or tap numbers of each service line to its corresponding property. At one glance the desired number is obtained, and turning to this number in the book of service-line records, which is compiled from the data turned in by the plumbers, is found a complete history of the underground work.

VALUE OF RECORDS—Where records of underground work are lacking a large amount of money is spent each year in locating pipes. For instance, on a residence street, a half mile in length, about to be paved, some $60 were spent in explorations—a common experience. Besides money wasted in such prospecting, there are other losses. As an example, after hunting for several days for a cross in a 10-in. main, the search was given up and three 1-in. taps were made for the intersecting 2-in. line. After the trench had been filled, one of the laborers struck the cross within 1 ft. of the excavation.

The cost of this blundering was: Prospecting, $10; tapping and lead connections, $15; cross (of no use now), $15; total, $40. If records of the special had been kept, the cost of this 2-in. connection could not have exceeded: Excavation and refilling, $2; melting out 2-in. plug and calking new joint, $2; total, $4.

*Engineer-Manager, Abilene, Kan.

A Gravity Switching Yard

SYNOPSIS—The use of gravity switching for the sorting of cars in making up freight trains is on the increase. The following article describes the new gravity yard just completed at Mechanicville, N. Y., for the Boston & Maine R.R. It covers also the arrangements for car storage and repair, and for handling the locomotives at this division terminal.

An example of the extensive work now being undertaken in the revision of freight yards to improve railway operating conditions is afforded by the new gravity switching yard of the Boston & Maine R.R., at Mechanicville, N. Y. The Fitchburg Division of this road extends westward to a connection with the West Shore R.R. at Rotterdam Junction, N. Y., and connects with the New York Central R.R. at Schenectady, a few miles east of that point. These are the main connections with western lines, and at Rotterdam a freight yard was maintained for handling the eastbound traffic received from these roads. At Mechanicville, 20 miles east of Rotterdam, there is interchange connection with the Delaware & Hudson R.R., and here a second yard was maintained.

In order to improve the operating service and the yard facilities, as well as to effect an economy in yard work, it was decided to concentrate the work of this terminal point in one large yard at Mechanicville, and to do the classification work in the yard by gravity switching instead of by the ordinary switching methods employed in the old yards.

At the new yard, which is now in operation, the eastbound cars received from other roads are made up into solid trains for different points on the Boston & Maine R.R. About 600 cars are received daily, and about 18 trains are sent out. The yard is about two miles long and comprises two main features: (1) the receiving yard, classification yard, and auxiliary facilities for switching service; (2) the engine terminal and car-repair facilities. The car capacity is about 3500 cars, as follows: receiving yard, 800; classification yard, 2000; hold yard, 200; repair yard, 200; transfer yard, 150.

Entering from the west is the double-track main line, with a descending grade of 0.55% and a curve of 2° 30′. This line passes along the north side of the yard. In general practice, the two main tracks are separated and pass around opposite sides of the yard, so as to avoid crossover switching of trains entering and leaving the yard. At this yard, however, no westbound business is handled, so that there is no necessity of spreading the main tracks. To the south of the main line is a dead-end siding 1500 ft. long, from which leads the ladder track of the receiving yard. The three tracks are connected by a pair of crossovers, as shown.

The receiving yard has 10 tracks, each designed to hold 80 cars, and with a clear length of 3200 ft. They (and the main tracks) are spaced 13 ft. c. to c., except that at the overhead bridge of the Hudson Valley Electric Ry. the two middle tracks are spread 20 ft. c. to c., to clear the middle pier. The west end of the yard has a single No. 7 ladder with No. 9 frogs, the distance between frog points being 91.47 ft. The yard has a 4° curve west and a 2° 45′ curve east of the bridge. Its eastern or leaving end is wedge shaped, with a No. 9 ladder on the north and a No. 7 ladder (with No. 9 frogs) on the south.

Beyond the receiving yard, the track passes a tank and engine standpipe and leads with a 6° curve onto the switching hump. From the summit, there is a steep accelerating grade followed by an easier grade to and through the classification yard. On each side of the hump is a runaround track on the ground level, 26 ft. from the hump track, so that cars needing repair can go direct to the repair tracks and cars put on the wrong classification tracks can be returned to the west end of the yard without passing over the hump. To the north of the hump is the caboose yard, having three tracks 525 ft. long. To the south of the hump are tracks leading to a private coal yard, and to the icing house and stock pens, which are of wood.

The cars having been inspected on the receiving tracks, and marked to indicate their destination on the classification tracks, a yard engine pushes a train of about 60 cars to the hump, a grade of 2% about 230 ft. long leading to the summit. Here the cars are uncoupled. The cars are started down beyond the summit by a first accelerating grade of 4%, 75 ft. long. This is followed by a second grade which is 2% for a length of 300 ft. and then 1% for 400 ft.; beyond this there is a uniform grade of 0.5% through the classification yard.

The scale is 55 ft. long, of 150 tons capacity, with automatic recording device, and in order to reduce the impact of cars running onto the platform, the rails of the approach track are laid on concrete walls forming an extension of the scale pit walls. The scale, however, is not yet in use. At the summit, a rider or brakeman mounts each car, to control its movement on the classification track. There are nine switchmen on the classification ladders, and each car is chalked to indicate its destination or track. This marking is done at the receiving track.

The classification yard is approached by two central ladder tracks (coming from the hump); these are 30 ft. apart, and between them is a track for a gasoline car to carry the car riders or brakemen back to the hump. These are No. 7 ladders with No. 9 frogs, and a distance of 91.47 ft. between the frogs. This yard has 35 tracks, each 2300 ft. long in the clear and holding about 60 cars. These tracks are spaced 13 ft. c. to c., except that the two middle tracks are 17 ft. c. to c. The north track of the yard is 16 ft. from the main track, and the south track is 13 ft. from the first of the two running tracks which provide for through movement through the yard. At the western end, the yard tracks lead off in opposite directions from the two central ladders, but at the east end the yard runs to a point between two outside ladder tracks, with the same frogs as at the west end.

It will be noted that there is no departure yard. The cars are classified by destinations in the classification tracks, and are thus at once made up into trains which are taken out directly by the road engines. Thus the tracks combine the functions of classification and departure tracks, and for this reason are fitted with compressed-air piping for testing brakes. It may be noted that the Yards and Terminals Committee of the American Railway Engineering Association, in its 1914 report, states that of 29 hump yards 16 have and 13 have not departure yards, but that reports from 28 of these favor the use of

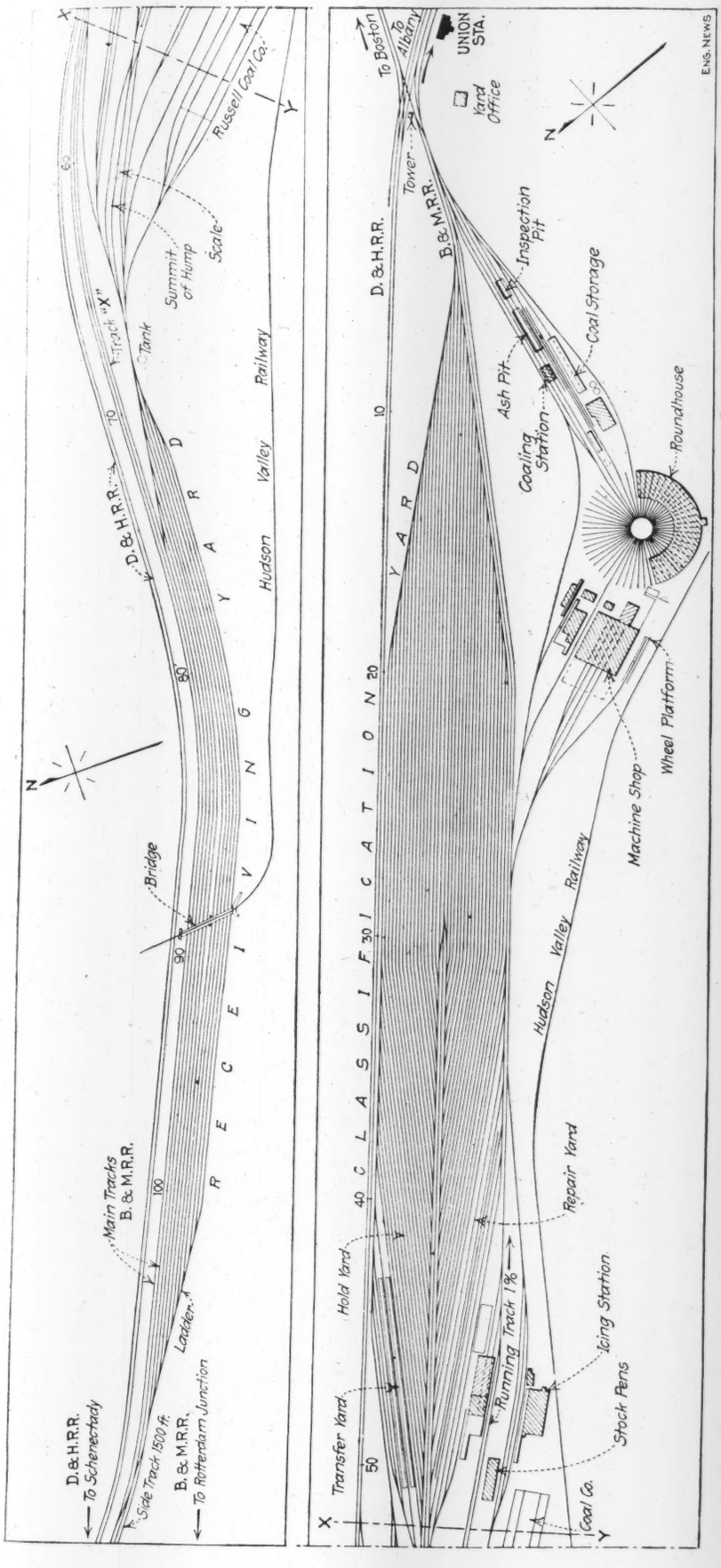


FIG. 1. PLAN OF NEW FREIGHT YARD OF THE BOSTON & MAINE R.R., AT MECHANICVILLE, N. Y.

departure yards. The advantage is in keeping the classification tracks free of trains, but in the Mechanicville yard the relation between the number of cars and number of tracks is such as to make the provision of separate departure tracks necessary.

Between the hump and the classification yard are the transfer yard and hold yard (north of the main ladders), and the repair yard and car shops (south of the ladders). The transfer yard is for consolidating less-than-carload shipments into full carloads, thus releasing certain cars for return. It has seven tracks 1000 ft. long. The middle track passes between two transfer platforms and is spaced 26½ ft. from its adjacent tracks, while the others are spaced 13 ft. c. to c. The hold yard leads out of one of the classification ladders, and is for cars which are held for orders or which have been sent over the hump without the proper destination being known. It has five tracks 1250 ft. long.

The two platforms in the transfer yard are 15 ft. 3½ in. wide and 800 ft. long, each having concrete walls and deck and a wood canopy roof, as shown in Fig. 2. Along each side, and embedded in counterforts of the reinforced-concrete side walls are posts of 4-in. cast-iron pipe filled with concrete, extending about 8 ft. below the platform deck and spaced 6 ft. apart. The deck or floor is marked off in 2-ft. squares, with all joints cut through the concrete and either sanded or separated with tar paper. The concrete mixture is 1:2:3, the coarse aggregate being crushed trap rock not exceeding ½ in. in size.

The car-repair yard has six tracks 1380 ft. long, each holding about 30 cars; its four outer tracks are spaced 18 ft., and the two middle tracks 22 ft. c. to c., with a wheel track between them. The entire repair-yard space is planked. The car inspectors' shop is a brick building. South of this yard are the car shop, storeroom, lumber storage and wheel-storage platform. Between these buildings and the icing station is laid the running track which provides for movements through the yard.

The engine terminal is at the east end of the yard. The roundhouse is nearly semicircular. It is of brick construction, with wood roof framing and monitor and wood smokejacks; it is divided into three sections by two brick firewalls. It is 100 ft. wide and has 25 stalls, the two tracks at one end being served by a transverse drop pit. The turntable is 85-ft. diameter, operated by power, and there is a space 80 ft. wide between this and the roundhouse. Opposite the roundhouse are 28 open tracks radiating from the turntable and used for holding engines making a short stay or not needing roundhouse service. Four of these

at the east and one at the west are through tracks, but the roundhouse is so located that no running track enters it, access being exclusively by the turntable.

To the west of the roundhouse are the machine shop (170x200 ft.), blacksmith shop, tube rattler building, storehouse, and shop office, and a lavatory and locker room for the enginemen and firemen. The machine shop is a steel-frame building with brick walls, and the other buildings named are of brick. To the east of the roundhouse is the steel and brick power house, 124x50 ft. This will supply electric current for lighting the yard and buildings and operating the coaling crane and other machinery; it will supply also compressed air for testing the car brakes and operating tools, and hot water for heating the buildings and washing out the locomotive boilers. The steel roof trusses carry a 90-ton bunker bin supplying the magazines of the automatic stokers in the boiler room.

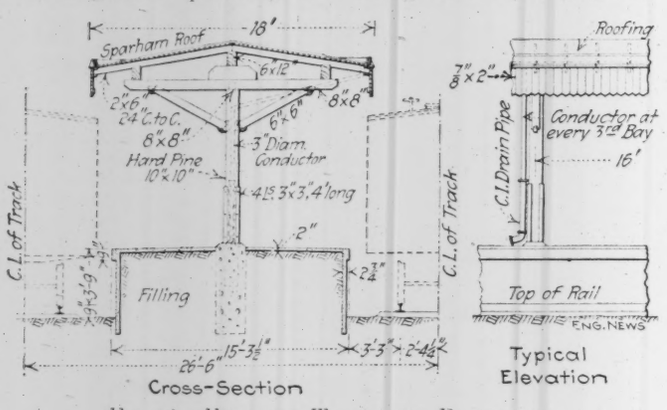


FIG. 2. FREIGHT TRANSFER PLATFORM

All road engines enter and leave at the east end. An engine entering the yard will stop first on the inspection pit (75 ft. long) while the inspectors look it over, and then at the ashpit (170 ft. long), both built for two tracks 15 ft. c. to c. Beyond these are the coal storage and the coaling station, and then the water station and sand spouts.

The ashpit is 6 ft. deep and 11 ft. wide on the bottom, with sloping sides, the outer rail of each track having laid on the side wall. The inner rail is carried by a stringer composed of a pair of 12-in. I-beams supported at intervals of 12 ft. by cast-iron posts on concrete pedestals, as shown in Fig. 3. The concrete of the slopes and pedestals is faced with firebrick, in order to protect it from disintegration. The bricks are laid in 1:1 cement mortar, and on the slopes the vertical joints are filled with neat cement grout. The facing bricks of the pedestals are laid up in the forms.

The coal-storage plant is shown in Figs. 4 and 5, the coal being stored in a concrete pit 250 ft. long, having a capacity of 2000 tons. The coal is delivered into this pit from cars standing on a trestle over the sloping side of the pit, and the trestle approach is 100 ft. long, with a grade of 5%. The trestle has 12-ft. spans composed of timber stringers (each consisting of two sticks 10x16 in.) resting on concrete piers.

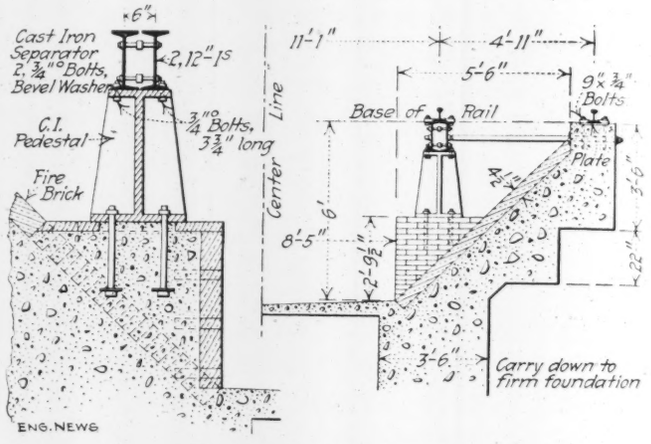


FIG. 3. ENGINE ASHPIT

The locomotive coaling station has a capacity of 600 tons, and serves engines on four tracks. It spans the two center tracks and has side chutes for the outer tracks. Between the coal storage and the coaling station travels a gantry crane (Fig. 1), with a track of 15-ft. gage, 525 ft. long; the trolley traveling on the gravity carries a 1½-yd. grab bucket. This crane is used for handling the coal from storage or from cars to the coal pockets, or from cars direct to the locomotives; it is used also in removing the ashes from the ashpit and loading them into cars. The water station has two engine standpipes serving the four coaling tracks, and engines are supplied with sand while taking water.

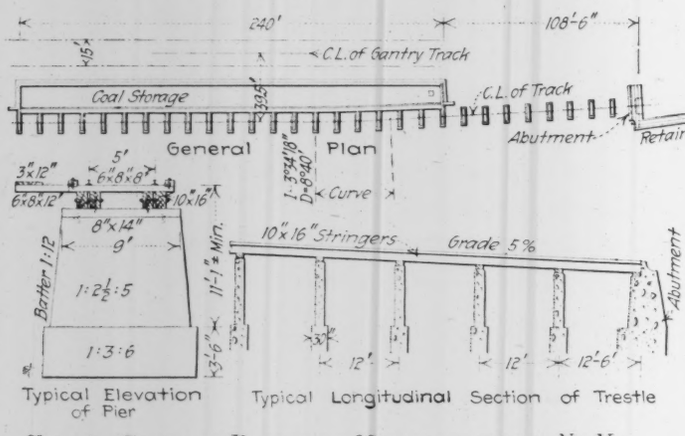


FIG. 4. COALING PLANT AT MECHANICVILLE, N. Y. BOSTON & MAINE R.R.

(Coal is delivered from cars on the trestle to the coal storage pit, from which it is taken to the coal chute by a grab bucket on the gantry crane.)

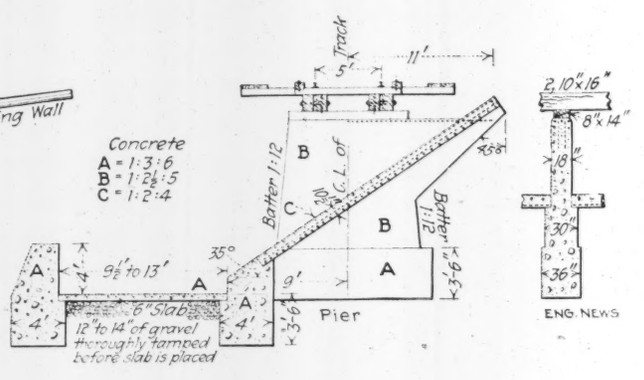


FIG. 5. TYPICAL CROSS-SECTION OF COAL-STORAGE PIT AND TRESTLE

tracks and the engine terminal tracks unite in a double-track line just before the crossing and junction of the Delaware & Hudson R.R., near the Union station.

The tracks are laid with 85-lb. rails on the ladders and 75-lb. rails elsewhere; the ties are of cedar, in gravel ballast, but are protected by tie-plates on leads and curves. The yard is lighted by arc lamps of 1800 c.p. Along the classification ladders these are placed 50 ft. high and 300 ft. apart. An 8-in. water main extends along the south side of the property, ending at the 50,000-gal. tank and engine standpipe at the west end of the hump. This is connected to the city main and serves a system of piping and hydrants with connections to the buildings and water station. A compressed-air main leads from the power house and supplies a pipe system for testing the brakes on cars in trains and in the repair yard. From this main extend 2-in. and 4-in. laterals, leading across the classification yard at intervals of 500 ft., with test outlets between alternate pairs of tracks.

The yard was planned and built under the direction of A. B. Corthell, Chief Engineer, and F. C. Shepherd, Engineer of Construction, Boston & Maine R.R. The resident engineer was G. H. Gove. The general contract was let to the Wilson & English Construction Co., of New York, which did all the grading, tracklaying and ballasting, as well as a considerable part of the concrete work. The roundhouse was built by the H. P. Cummings Construction Co., which also laid the water-piping system. The car inspectors' building and the transfer platforms were built by the Nial Brothers Construction Co., of Troy, N. Y., and most of the other buildings by the H. Wales Lines Co., of Meriden, Conn. Work was commenced in August, 1912 and was completed in January, 1914. The total cost was nearly $1,500,000.

Water-Tight Sewer-Pipe Joints in Brooklyn

By E. J. Fort*

The drainage plans for several square miles of territory in the southern portion of Brooklyn, in the neighborhood of Coney Island, Sheepshead Bay, Jamaica Bay, etc., where surface elevations are low, provide for a separate system of sewers, in which, in most cases the sanitary sewers are below the level of ground water, and in all cases the domestic sewage must be pumped.† This made the matter of water-tight pipe joints one of great importance.

At the beginning of this work, the Bureau of Sewers had had no experience in the use of the various compounds offered on the market for this purpose, and had little information in regard to their merits.‡ It was thought best, therefore, to depend upon extreme care in the use of cement mortar with a hemp or oakum gasket for the desired results until the various compounds available could be thoroughly tested. The first few contracts let, therefore, provided for cement-mortar pipe joints. The mortar was mixed in the proportion of one to one and was liberally used. In most cases, where pipes have been laid below ground-water level, they have been laid in a concrete cradle, and where the pipe joint is not buried in the cradle it is inclosed in a cement collar at least 2 in. thick outside the bell. When the contractor and inspector can be relied upon for careful and conscientious work, a pipe joint made in this manner and allowed several hours to set before water is allowed to rise over it will be practically water-tight under heads of water as great as 8 ft. These individuals, however, cannot always be relied upon, and a very slight injury to a joint made in this manner will produce a leak.

Use of a Compound for Joints

A compound suitable for sewer-pipe joints should possess the following properties:

(1) It should show no deterioration when submerged in either fresh or salt water or in alkaline or acid solutions of moderate strength. Domestic sewage usually has an alkaline reaction, but frequently in the neighborhood of factories it has an acid reaction. In certain places, ground water is heavily charged with alkali. The life of the sewers as water-tight structures will be measured by the life of the joints.

(2) It should melt and run freely at temperatures not greater than 250° F. It should be poured at a temperature of approximately 400° F. to make certain that the joints are thoroughly filled. It is not usually possible in wet trenches to keep the ends of the pipes dry and the temperature at which this material is poured should not be so high that steam is rapidly generated where it comes in contact with moisture with the result that either the compound is made porous or the runner is blown out.

(3) It should adhere well to the glazed surface of stoneware pipes so that slight movements in these pipes after the joints are poured will not produce leaks.

(4) At temperatures which prevail in and about sewers laid under such conditions, the compound should be elastic enough to permit of slight movement without fracturing the pipes, but should not become soft enough to run out of the joints. Such movements very frequently occur in unstable soils.

(5) It should not be composed of materials which volatilize rapidly at comparatively low temperatures, so that men working with the ordinary skill and care of the average sewer contractor or contractor's foreman can use it successfully.

Every material on the market, samples of which could be obtained, was tested to determine the degree to which it possessed the qualities named. They were all found more or less defective, so that they could not be used with any assurance that they would produce permanently tight joints.

The various compounds in which sulphur is used were found to shrink upon cooling, either separating from the pipes or cracking so as to admit water. Compounds having certain oils as bases disintegrated rapidly when exposed to the action of alkalies, although they resisted the action of acids very satisfactorily. Certain compounds having bituminous materials (generally pure or nearly pure asphalt bitumens) as bases after they were modified in composition somewhat by the manufacturers, were found to resist the action of both acids and alkalies satisfactorily and possessed all of the qualities mentioned above. One of these compounds is manufactured in Brooklyn. Both "Jointite" and "Filtite," which are manufactured by the Pacific Flush Tank Co., have proved

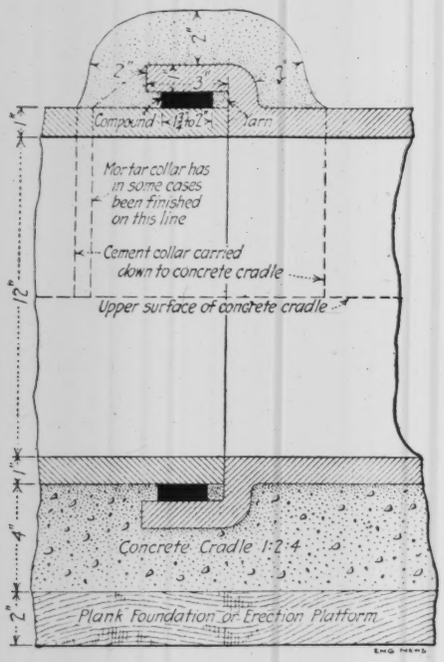
*Chief Engineer, Bureau of Sewers, Borough of Brooklyn, New York City.

†See "Eng. News," Nov. 27, 1913, for description of these sewers.

‡See "Eng. News," Mar. 19, 1914, for article by A. Elliott Kimberly on "Poured Sewer-Pipe Joints," to which this article is in a measure supplementary.—Ed.

to be very satisfactory. The chemicals used in these tests were a 1% solution of hydrochloric acid and 1% and 5% solutions of caustic potash. Samples were submerged five days in these solutions.

"Jointite" has been used for all sewer work of this kind which has been done in Brooklyn, with very satisfactory results. Experiments were also made in the laboratory with this compound to determine the highest temperature to which it could be safely heated and the length of time that such temperature could be maintained without danger of carbonization or destroying its flexibility. As a result of these experiments and later experience, the temperature at which it is poured is allowed to vary from 350° to 450° F., depending on the diameter of pipe and the season of the year. The compound is not held at this temperature longer than 30



SEWER-PIPE JOINT MADE WITH COMPOUND AND PROTECTED BY A CEMENT-MORTAR COLLAR, BROOKLYN, N. Y.

minutes, and it is not allowed to be reheated and used after having once cooled.

In the new Coney Island drainage system, and in other places in the Borough where the depth at which the sewers are laid below ground water is not more than 12 ft., as a general thing there is absolutely no leakage through the joints except in cases of accident or pure carelessness. We have found that the spur joint where a branch joins the main sewer is frequently carelessly made and admits water. Caps for house connection drains and for spurs are also frequently carelessly placed with the same result.

HOW THE COMPOUND JOINTS ARE MADE AND PROTECTED

The accompanying sketch shows the manner in which pipe joints of this kind are made. A twisted hemp or oakum gasket of the proper size is first carefully rammed into the joint and occupies a depth of approximately ¾ in. A runner, usually a piece of old garden hose, is greased or smeared with wet clay and forced into the bell about ½ in. The ends are secured by a clamp in the usual manner so that the space for pouring is at one side of the crown of the pipe. The best results have been received by pouring so that the compound will run entirely in one direction about the joint, as it drives all the moisture ahead of it and completely fills the space between the bell and spigot.

In the case of pipes as large as 20 in. in diameter, where the space between the bell and spigot is very uneven, there have been numerous instances where the compound cooled so rapidly that it failed to pass the narrowest portions of the space and make a complete joint. For that reason, it is well to pour a full stream, so that it will entirely fill the space in which it runs. It is also well to remove the runners as soon as the compound has cooled sufficiently to stand alone, but while it is still hot so that any imperfections that may be found can be corrected by calking with compound hot enough to be plastic.

While it is possible to pour joints while the pipes are partially submerged, this procedure is not recommended, because of the great liability of producing imperfect work. It is our practice to run one-half of the joints before the pipes are placed in the trench. These joints are made with the pipes in a vertical position and without a runner. The pipes are then placed in position in 6-ft. lengths. At least a half-dozen joint runners are on hand and all the joints to be poured are made ready and poured at one operation without waiting for each one to cool so that the runner can be removed. In this way the danger of injuring the compound by keeping it at a high temperature for too long a time is lessened. The concrete cradle and the mortar collars are placed after the pipes have cooled. The former is used for the purpose of securing greater stability in unstable soil; the latter is used solely as a protection for the joint compound.

The repair of pipe joints several feet below water level, especially where, as in sandy soil, the inrush of water in the trench is great, is a very expensive operation and is always accompanied by the danger of injuring adjacent portions of the sewer. Such leaks are liable to continue for some time before they are discovered and to run up large bills for pumping before they are repaired. In my opinion, therefore, the cement collar in protecting the joint compound from direct contact with water or chemicals on the outer end, as it is protected on the inner end by the jute gasket, is worth all it costs.

The weights of "Jointite" used in jointing vitrified pipes of various diameters have been carefully determined. All of this pipe was double strength and had deep and wide sockets or bells. The weights were as follows:

Size of pipe, in.	Thickness of joint, in.	Depth of joint, in.	Weight of material per joint, lb.
6	⅝	1½	1.04
8	⅝	2	1.84
10	⅝	2	1.84
12	⅝	2	2.70
15	⅝	2	3.32
18	⅝	2	3.80
24	1	2	8.50

Average specific gravity, 1.50.

The cost of labor in making joints in this manner, so far as it could be determined, was almost exactly double the cost of making plain mortar joints. It is usually very difficult to determine this cost correctly, because the contractor considers joint making one of the minor operations which does not require much care or system, and it is left to a "skilled" laborer or the inspector to manage the operation.

Rebuilding an Old Wood Penstock

By C. A. Edwards*

Old Penstock—The Gothenburg power canal and works were built in the year of 1890 and 1891. Water is taken from the Platte river at a point 10 miles west of the city of Gothenburg, Neb., and is carried in a canal along a contour line to a reservoir, just north of the city. This lake is 53 ft. higher than the river at this point, and there is 46 ft. fall available for power. To avoid a long and deep canal excavation, a penstock was built from the lake to the power house, a distance of 868 ft. For the intake, a set of cast-iron gates and frames were built into a wooden structure, 12 ft. square by 16 ft. deep. The gates had a hand screw for raising and lowering. Water passed through a wood screen 12 ft. in depth. The penstock started at the bottom of the intake frame and was 72 in. in diameter. It was built of 2½-in. wood staves, banded with ½- and ⅝-in. soft-steel bands, two lug shoes to each band, and spaced from 3 to 7 in. apart as the pressure required.

At the intake, the wood penstock passed through a concrete curtain wall 6 ft. thick and reaching above high-water mark in the lake. The penstock was originally covered with loose sandy soil 2 ft. deep but the wind and rain had uncovered portions and these had decayed badly from the outside.

The inner surface was always sound but, at the end of 10 years, leaks began to show up, caused by the decay on the outer surface which allowed the staves to spring out of place under pressure.

At first all repairs were made by replacing the poor staves with new ones. Then the patching was done by nailing a sheet of 22-gage iron on the inside over the leaks. This was kept up till early in 1913 when the leaks got to be so numerous and bad that the company decided to build a new penstock.

Estimates were made for reinforced concrete, steel and wood staves. The old wood staves had lasted 22 years, so wood staves were selected again, but the thickness of the stave was reduced to 3 in. so as to have better saturation. All old lugs and bands were used again, the bands being rethreaded and new nuts furnished (the old nuts had to be split in taking off the bands). All tongues at the stave ends were new.

New Wood-Stave Pipe—In building the new line, first, a section was built at the lake or upper end and pulled through the old concrete curtain wall and 2 ft. beyond. Then a new wall was built on the end of the staves, the concrete being well tamped to make it enter the space between wall and staves. This wall was carried 2 ft. above the staves. All timber work was removed from the intake and replaced with concrete, the old cast-iron gates and frames being reset. After concreting around the staves, an empty space was found under a part of the penstock so an 1½-in. hole was bored through the staves and a rich cement mortar forced in under 4-ft. head.

As forms for the wood-stave line, two lengths of 2-in. gas pipe were used, bent to a semicircle of 38-in. radius, and two semicircular fans built of 1-in. lumber 72 in. in diameter.

After excavating the old trench 7 ft. wide and 4 in. below grade, the pipe forms were placed 12 to 14 ft. apart and the staves were started in the bottom. They were truly centered with tongue in end and were driven nearly up, the two sides being kept of even height, alternate staves breaking joints by about 4 ft. Fig. 1 shows the start over some concrete piers in unsettled ground; Fig. 2 shows how the fans were used, no bands being placed till all the staves are in place. Then the bands were placed 2 ft. apart and lightly tightened. The staves were next driven up but with care to prevent another blow after the butts were tight. Finally, the full number of bands was placed. When the fans were removed, a vertical strut, 6 ft. long, was placed inside the pipe to keep the top from sagging. The pipe forms were bent forward, before bands interfered, and were easily removed for starting another length.

Fig. 1. Fig. 2.

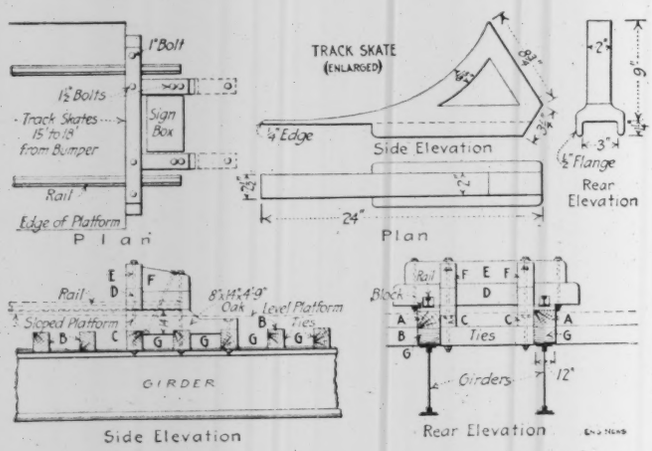
Rebuilding a Wood Penstock at Gothenburg, Neb.

Approaching the connection to the steel drum at the power house (leading to wheels), water from old leaks had washed away the dirt, so concrete piers were built, about 16 ft. high. Then 50 ft. back from the building, two concrete deadmen were put in place of old pile and timber work; the penstock rests on these deadmen and six 1¼-in. iron rods, with turnbuckles, connect the deadmen to the steel drum and carry the end thrust of the pipe. The connection to the steel drum was made by flaring the wooden pipe (inserting an extra beveled stave) until the space between wood and steel was ½ in. This was calked with oakum and lead. The pipe and all connections were tight, except the lead joint, last mentioned. The more this is driven, the more it leaks; a reinforced-concrete collar will have to be placed around this joint to make the penstock perfect. The whole penstock line was covered with 2½ ft. of earth.

*Gothenburg, Neb.

Bumpers and Track Skates in the Broad St. Station, Philadelphia

In large passenger terminal stations, the car bumpers at the ends of the tracks are usually of the high type, engaging with the couplers and striking blocks of the cars and locomotives. At some stations, however, they are of the low type, engaging the wheels only. This latter type is used in the Broad St. station of the Pennsylvania R.R., at Philadelphia, and the design is of particular interest in being used in connection with track skates upon which the wheels run before they engage the bumper. For information as to the above arrangement, we are indebted to W. G. Coughlin, Engineer of Maintenance-of-Way, Pennsylvania R.R.



BUMPERS AND TRACK SKATES IN THE BROAD ST. STATION AT PHILADELPHIA, PENNSYLVANIA R.R.

About a year ago, the bumpers or bumping blocks were changed in order to permit of additional standing room for cars and additional space for trucking between the rear of the bumpers and the fence of the concourse. The accompanying cut shows the present construction of the 12 bumpers. The rails in the station tracks are carried by longitudinal timbers or stringers *A* (with cushion blocks between these and the rails), and the stringers rest on cross-ties *B*, bolted to the girders of the floor system.

Against the inside of each stringer *A* is fitted a heavy oak timber *C*, resting directly on three of the ties and boxed out for these ties. These timbers carry two superimposed transverse or bumper timbers *D* and *E*, and also the two sets of backing timbers *F*. The whole framework is well bolted together, and filler blocks *G* are fitted between the three ties under the bumper and the next two ties beyond, so as to form a solid framework to resist shock. It will be seen that the rear part of the bumper sills is below the platform, thus making available a space formerly useless. A sign box 19x30 in. is placed behind the bumper.

About 15 to 18 ft. in advance of the bumper are placed the track skates, shown in the cut. These stop the revolution of the end wheels, and slide upon the track rails, giving considerable frictional resistance. In this way, the momentum is checked before the skates reach the limit of their travel, and come home against the bumpers.

Specifications for Slag Foundation for Brick Pavement

Readers of the article in ENGINEERING NEWS, Jan. 15, 1914, p. 108, on "Blast-Furnace Slag as a Foundation for Paved Streets," will recall that the author, Harvey F. Brown, Engineer of the Borough of Charleroi, Penn., came to the conclusion that slag, under proper methods of construction, is an excellent foundation material for paved streets, and is the nearest approach to natural concrete obtainable. The use of slag means a saving over a concrete foundation of approximately 30c. per sq.yd.—in the iron and steel districts where slag is readily obtainable.

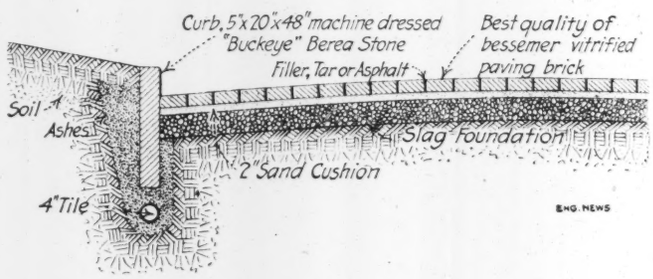
Since the article referred to was published, we have been informed by William V. Alford, City Engineer of Niles, Ohio, that slag has been used with much success under brick pavements in that city. Specifications for these foundations are as follows:

(1) Specifications for grading, rolling and crowning the earth foundation, or subgrade are to be the same as for concrete foundation.

(2) SLAG FOUNDATION—There shall be placed on the subgrade 6½ to 7 in. of air-cooled, blast-furnace slag, from the Carnegie Steel Co., of Youngstown, Ohio, or slag of the same specific gravity. This shall be the crusher-run slag not larger than 3 in. in any dimension. It shall be evenly distributed over the subgrade. This can best be done by the use of wooden blocks, as directed by the engineer. When thus leveled the slag shall be rolled until there is no appreciable settlement. While thus rolling careful examination of low places in the foundation must be searched for and when found the slag must be loosened with a pick and rerolled with sufficient added material to bring the low spot to an even grade and surface level and of the same density as the rest of the foundation.

(3) The slag foundation shall be rolled with a 10-ton steam-roller, weighted if directed by the engineer. The rolling shall begin at the curb and work toward the crown, the spacing of the rolled portions to be as directed by the engineer. The rolling shall progress toward the center until the entire foundation has been keyed in at the crown, and all interstices have been reduced to a minimum, in the judgment of the engineer, and all low places corrected.

(4) SLAG SAND—Slag sand shall be placed on the foundation and worked into all voids by sweeping with a steel or rattan broom. The sand must be evenly distributed over the slag foundation with shovels, from convenient sand piles placed on the berm of the roadbed. After each passage of the roller the sand must be thoroughly "hetcheled" with a stiff brush as above noted. This process shall continue until there is a smooth, hard and convex surface, acceptable to the engineer.



BRICK PAVEMENT WITH SLAG FOUNDATION, NILES, OHIO

Water shall be applied by sprinkling as directed during the last half of the rolling in of the sand. It shall continue until a grout is formed with the slag sand and water, which must wave slightly before the roller.

The foundation is now ready for the cushion of sand. This sand cushion shall be placed as noted in the specifications for concrete foundation.

Selection of Pumps for Small Water-Works

By W. E. Housman*

It is evident, to anyone visiting the smaller water-works installations in his vicinity, that the pumping plant has not secured sufficient skillful study in its design. By small water-works, the writer refers to those in which the duty required is under 1,000,000 gal. per day. In this age of electricity, our old and tried friend, the steam pump, is often forced into the background without proper consideration of the pumping conditions.

Either one of two governing conditions obtains in small water-works: (1) the pumps discharge directly into the service mains; (2) the distribution pressure is dependent upon the height of water in a standpipe or reservoir into which the pumps discharge.

It is not generally realized how many installations are in use where no standpipe or other storage obtains. The small water-works cannot usually be prevailed upon to pay for a standpipe so long as satisfactory service can be had without it. This condition necessitates a service of variable delivery with a pressure head maintained as nearly constant as possible. Therefore, the load on the pumps is constantly fluctuating. The heaviest demand occurs in the morning; it then falls off, rises at noon and falls off again. Toward evening, there is a fair demand, especially in summer, but it drops off until, at midnight, there is little water required. But where a standpipe or other storage can be used, the pumps can deliver at maximum duty and consequently at best efficiency while operating and can be shut down during the appreciable interval elapsing before the pressure is too much reduced.

The fact must also be considered that some suction lift has to be overcome by the pump in most cases.

The crank-and-flywheel steam pump may be eliminated at once as being too expensive; there remain the "direct-acting steam pump," the "motor-driven triplex pump," and the "motor-driven centrifugal pump."

The objections to the direct-acting steam pump are that it is very wasteful of power and requires boilers. On the other hand, it is a most reliable machine and ordinary repairs and renewals do not require expert labor. When controlled by a water-pressure governor it is a most flexible machine adapting its power consumption to the amount of the load. For most of the suction conditions met with, neither priming device nor foot valve is required, as, when properly packed, the pump will readily lift the water after a long shutdown.

Compounding the steam end gives little or no saving with the variable load of pumping directly into the mains, but on standpipe service the greater economy will show a good return on the extra cost and compensate for the complication. Compounding, without standpipe service, may be advisable if emergency high pressure is required for fire-protection. For this, with the pump properly designed, live steam can be admitted to the low-pressure cylinder and the line pressure increased to the desired amount. Noncondensing units alone are considered because of small size.

The motor-driven triplex unit is not well adapted to pumping on the line. Where the electricity supply is alternating current (and that is the situation in probably the large majority of cases) a constant-speed induction motor must be used. (The speed can be varied by inserting resistance in the rotor circuit but the writer believes that is too wasteful to be considered here.) To guard against partial or total closure of the discharge line, it is necessary to insert a relief valve set at a little more than the line pressure. It follows that for all conditions except maximum delivery, the relief valve is in action; in short, a triplex pump working directly on the line may be expected to consume full-load current all of the time it is in operation; the operator will not stop the pump every time the demand falls off because he may lose the water in the suction pipe and have to prime the pump.

On standpipe or equivalent service, the triplex pump is a very efficient machine since it is either idle or is working at its maximum efficiency. The periods of shutdown can here be made long enough to compel proper regulation. By a float-operated control, the pump can be automatically stopped and started, requiring only that the attendant see to the priming where necessary.

In all triplex pump installations a surge tank or equivalent cushion is desirable near the pump to overcome the disruptive hammer on the line so often encountered. A priming device is also desirable—either a small auxiliary vacuum pump, or a tank holding at least twice the contents of the suction line and used with a foot valve in this line. While the pump will lift from any reasonable depth without priming, there is danger of breaking the

TABLE I. ESTIMATES OF PARTIAL INSTALLATION COSTS OF SMALL PUMPING UNITS

For Two 10-In. Simple Duplex Steam Pumps	
Two pumps, delivered and erected	$3,200
Foundations	350
Two 80-hp. return-tubular boilers bricked-in and erected on foundations with steel stacks	2,220
One 150-hp. feed heater and two feed pumps	450
Steam and exhaust piping, covered and erected	850
Brick building (27x58 ft.)	3,700
Total	$10,770
For Two Tandem-Compound Direct-Acting Steam Pumps	
In this estimate the increased cost of the pump is about offset by the decreased boiler capacity required and the building would be the same, hence the estimate of	$10,770
For Two 600-Gal. Triplex Pumps	
Two pumps with motor and starting apparatus	$4,300
Foundations	550
Wiring and erection	500
Building (30x26 ft.)	1,400
Total	$6,750
For Two 600-Gal. Centrifugal Pumps	
Two pumps with motor and starting apparatus	$2,100
Foundations	250
Wiring and erection	400
Building (24x28 ft.)	1,200
Total	$4,250

TABLE II. ESTIMATED OPERATING CHARGES, ETC. FOR SMALL WATER WORKS PUMP INSTALLATIONS

Type of pump	Assumed overall efficiency of pump, per cent.		Assumed steam, lb. per water hp.		Cost of installation		Cost per yr. Electric current @ 3½c. kw.-hr.		Cost per yr., coal @ $2.50 per ton		Interest and depreciation on investment @ 12½%		Oil, waste and repairs	Total yearly charge	
	Pumping into mains	Pumping into standpipe	Pumping into mains	Pumping into standpipe	Pumping into mains	Pumping into standpipe	Pumping into mains	Pumping into standpipe	Pumping into mains	Pumping into standpipe	Pumping into mains	Pumping into standpipe		Pumping into mains	Pumping into standpipe
Duplex steam pump			80*	60*	$10,770	$10,770			$1506	$1369	$1346	$1243†	$215	$3067	$2827
Triplex	60†	60†			6,750	6,750	$8380	$4190			$844		135	9359	5169
Centrifugal	47†	52†			4,250	4,250	5351	4843			531		65	5947	5439

* Including 10% additional overall loss of efficiency due to slip, etc., added in all cases † Not including 10% slip loss, etc.

*901 Swetland Bldg., Cleveland, Ohio.

pump as the water first starts to fill the chambers, it being remembered that there can be no cushioning.

The centrifugal pump is a machine designed to work under certain fixed conditions of head and volume. For any other, there is either a marked falling off in efficiency or, if the head has been greatly increased, the pump may not be able to deliver any water. In the small capacities here considered, the efficiency for any fixed service condition is low compared with that secured by the centrifugal pumps of twice the capacity, due to the heavy water friction loss in the small machines.

The centrifugal pump is very well adapted for service either directly on the line or into the standpipe. When pumping into the mains, the pump will build up a pressure materially higher than that for which it is designed, for all deliveries less than the maximum. The power decr and will decrease somewhat with the lessened demand for water. Should the line be entirely closed, the pump will continue to work at a pressure higher than normal but with no ill effects. From this it may be seen that, aside from the low efficiency of the pump, this type makes a very flexible machine.

However, should a break occur in the line, or a circumstance arise demanding materially more water than the designed capacity of the unit, the pressure will at once drop; then the pump will deliver, at the lower head, a very much increased volume. Unless the pump is specially designed to meet this contingency, the motor will become so much overloaded as to overheat or even burn out.

For fire purposes, centrifugal pumps readily admit of a design allowing them to be operated in parallel for a larger volume, or in series for an emergency higher pressure.

Therefore, except for (1) the necessity of priming and (2) the decrease in efficiency with diminishing size, the centrifugal pump is ideal for standpipe service. For such service the writer advocates pumping into the tank or reservoir at highest level—to secure constant head and volume while working.

For priming a centrifugal unit, the same vacuum pump or the priming tank already mentioned may be used.

It seems of interest to append tabulated figures prepared in the course of an engineering study of the pumping plant for a proposed municipal water-works of small size. These figures show a comparative estimate of yearly operating charges for the three types of pumps above noted. In each case, the capacity of the pump is assumed at 600 gal. per min. under 200 ft. total head; the piston speed of the triplex and steam pumps is taken at 80 ft. per min. In each installation there is a spare pump. It is further assumed that for pumping directly into the line, the pumps will be in action 16 hours per day with an average demand throughout this period, of one-half pump capacity. When pumping on the standpipe, it is assumed that the pumps will operate at full capacity for eight hours.

For the steam pump, the writer selected simple steam ends for line service, and compound steam ends for use on the standpipe. A spare boiler is figured on in each case and the estimated cost includes steam and exhaust piping, feed pumps, feed heater, etc.

It is to be understood that the cost estimate includes no items common to all three types of pumps and is not intended as a complete estimate. Such items as wa[ter] piping, standpipe, etc., are not included. Attendan[ce] cost is assumed to be the same as it is found that the fireman at the steam plant can and does care for the pumps. For any other current charges, or price of coal, the stated charges can be varied to suit. In the writer's estimation, they represent a fair average of the conditions obtaining in the small communities. The figures are given in the Table I.

To obtain the coal required, the assumed steam consumption multiplied by the hydraulic horsepower and divided by 34.5 gives the boiler-horsepower load. With a 4½-lb. (per boiler hp.-hr.) rate and a liberal amount for banking the estimated figures result. This coal rate is excessive for a large and very good plant using good coal; it should be increased for a poor plant and poor coal but may be decreased for very good coal. Moreover, the steam consumption given would be materially increased for old pumps in bad repair or units with poorly adjusted valves.

Electricity for Pumping*

By J. M. Bryant†

In many small places, water-supply systems could be installed if the cost of operation could be brought within the means of the community. Even in many larger systems, there is room for improvement in operating costs; for the steam-driven pumping station, the large items in operation expenses are for fuel and attendance. Both of these items are either absent or lowered materially with electrically driven units. Very many of these small communities have an electric-generating station or are within easy reach of some transmission system. In this discussion, it will be assumed that electric power is available at a fair rate. The problem of electric pumping then becomes an analysis of (1) first cost of equipment; (2) cost of operation including fixed charges, power, repairs and labor; (3) reliability of equipment.

Cost of Pumping Units—A comparison of the cost for steam and electrically driven pumps of the same capacity reveals the fact that the electric equipment costs from one-fourth to one-half that of the steam-driven units. Considering that, for new installations, a saving is also made in the first cost for boilers, buildings, etc., it certainly is fair to assume that the cost of the power plant or portion of the water-works equipment is reduced to one-fourth that for steam-driven stations.

In order to analyze the effect of this reduction on the annual fixed charge, the accompanying table is made from average figures for 22 cities in Wisconsin from reports of the Wisconsin Railway Commission. (7 Wis. R.R. Com. Rep., 301; 8, 341).

It may be seen that the total cost in power-plant equipment and buildings represents 15.23% of the total cost new of the equipment. Lowering this to one-fourth of its present value by the use of electric machinery brings a saving of 11.4% in total first cost and a reduction of 1.7% in annual cost of pumping (with fixed charges at 15% of first cost).

Cost of Operation—Items in the annual cost of operation which are less in the motor-driven station than for

*From a paper before the Illinois Water Supply Association, March 10, 1914.

†Assistant Professor of Electrical Engineering, University of Illinois.

AVERAGE COST NEW OF WATER-WORKS SYSTEMS IN 22 WISCONSIN CITIES

	Per cent. of total cost new
Land	3.10
Wells, intakes and suctions	8.39
Filters, reservoirs, standpipes	6.28
Distribution system	63.75
Power-plant equipment	8.86
Buildings and miscellaneous structures	6.37
Office furniture, appliances, tools, etc.	0.80

other steam or gasoline-driven pumps are:

(1) Interest on the investment—on account of lower investment (explained above).

(2) Depreciation of the centrifugal pump and electric motor. Depreciation on the motor is almost negligible if it is properly housed and cared for. The motor may have to be laid aside on account of obsolescence, due to improvements in electrical equipment, but this would secure additional saving in cost of operation to support the replacement burden.

(3) Cost of motor repairs; negligible in comparison with those for a steam- or gasoline-driven unit, on account of the absence of steam and heated gases and of reciprocating parts.

(4) Cost of motor attendance. If the pumps can be located near the power plant, no attendance need be provided outside of that which the power company is willing to furnish for the privilege of cutting off the demand of the large motors at the time of their station peak loads. For large stations and for isolated plants, one attendant can care for a large number of motors and pumps.

(5) Cost of lubricating oils—the pumps and motors are nearly always self-lubricating, using the same oil many times over.

(6) Maintenance and standby costs. Fires in a steam plant have to be kept banked at times of no load and ready to take on fire pumps. Fuel for banked fires forms one of the large items in the annual operation sheet of small plants.

Reliability—Reliability in pumping is of the utmost importance. In many installations this has been sacrificed, to lower the first cost of equipment. There may result from this neglect, low pressure in the water mains, and lack of volume for fighting fires causing excessive fire losses and also high insurance rates on real estate for such cities. The electric motor itself is more reliable than the steam or gasoline engine. In order to increase the reliability of the whole electric system the following suggestions are given.

(1) The motors should be located above all possible flood levels. A few cases are known of motor-driven mine pumps operating under water, but the insulation is not usually guaranteed to stand such treatment.

(2) Instead of installing one large motor and pump to furnish the total amount of water for high-pressure service, at least two units, and preferably three, should be installed. When installing three units, the combined capacity of any two should be able to supply the peak load of the station. This allows the unit or units in operation to run without throttling and at their full capacity. Throttling a centrifugal pump, or running it below speed, lowers the efficiency of the equipment and raises the cost of power by requiring more energy to pump the same amount of water.

(3) When the pumping-station is situated at some distance from the power plant, duplicate pole lines should be installed and over routes widely separated. When wires pass through city streets, a fire in a given quarter may destroy one pole line but service may be maintained over the other line. Repairs may also be made on either line and at any time without interrupting the operation of the station.

(4) Proper lightning protection should be provided at both ends of these lines. The electrolytic arrester has been found to be the most reliable type. Its first cost is slightly higher than that of other forms, but it gives better protection against lightning or high-voltage disturbance from other causes. It operates on the principle of a safety valve, discharging excess electrical pressure from the line, stopping the discharge at normal pressure and automatically setting itself for the next discharge.

Choice of Motor—The electric motor can be adapted to drive any type of pump. The greatest efficiency of mechanical transmission is, of course, secured by the least amount of gearing or belting. The centrifugal pump lends itself best for motor drive since it runs most efficiently at the higher speeds. The higher the speed, the lower the cost of the motor and pump. Information in regard to the proper choice of speeds can always be obtained from the pump and motor manufacturers.

There may be occasional special situations where direct-current motors may be used—such as in towns where electric-railway feeder lines may be tapped. However, the great majority of motors used for such service must be for alternating currents.

The squirrel-cage induction motor is a little more simple and reliable than the wound-rotor types. It is suitable for starting centrifugal pumps of small capacities without too great a starting current by the addition of a compensator if the pump outlet is closed when starting. The wound-rotor motor, with slip rings and external resistance, is preferable for sizes above 50 hp. in order to secure the higher starting torque with low-line current. Resistance in the primary or line side of the motor for starting should not be used, since the motor then draws from two to five times full load current from the line at the start. This is avoided by the use of the compensator starter or the slip-ring motor.

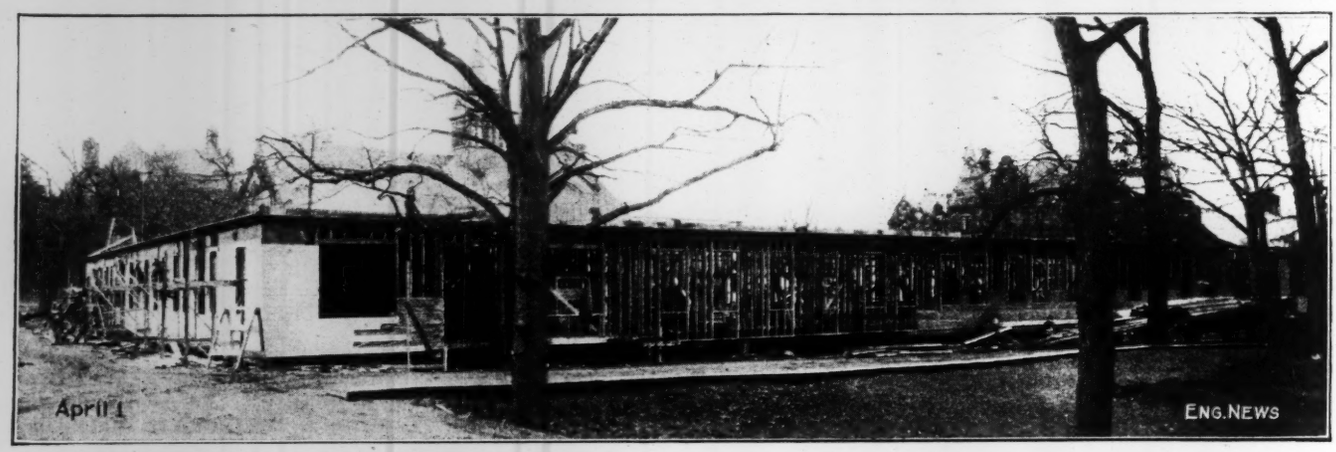
Cost of Power—Electric power for pumping should receive the lowest rate of nearly all classes of service furnished by a power plant. With water-storage facilities in reservoirs and standpipes, capable of taking care of the peaks in the pumping demand and also supplying the water for the two or three hours in the day when the commercial load on the station is the greatest, the power for the pumps may be supplied without any increase in the station maximum demand. The increase in the station output incident to this load will then improve the load factor, lowering the cost of producing unit power. The proper rate to be charged in any community should be properly determined by a competent engineer or by a commission, and not left to the governing body of the community and the public utility without expert advice. The public utility should be encouraged to seek the pumping load and the city to coöperate in securing a price giving justice to all consumers. This coöperation should extend not only to the matter of securing rates, but also in installing the equipment best for all concerned and of operating it at times when the company can best afford to supply the power. This same rule should also apply to combined municipally owned plants; each part of the service should bear its proper portion of the fixed and variable charges.

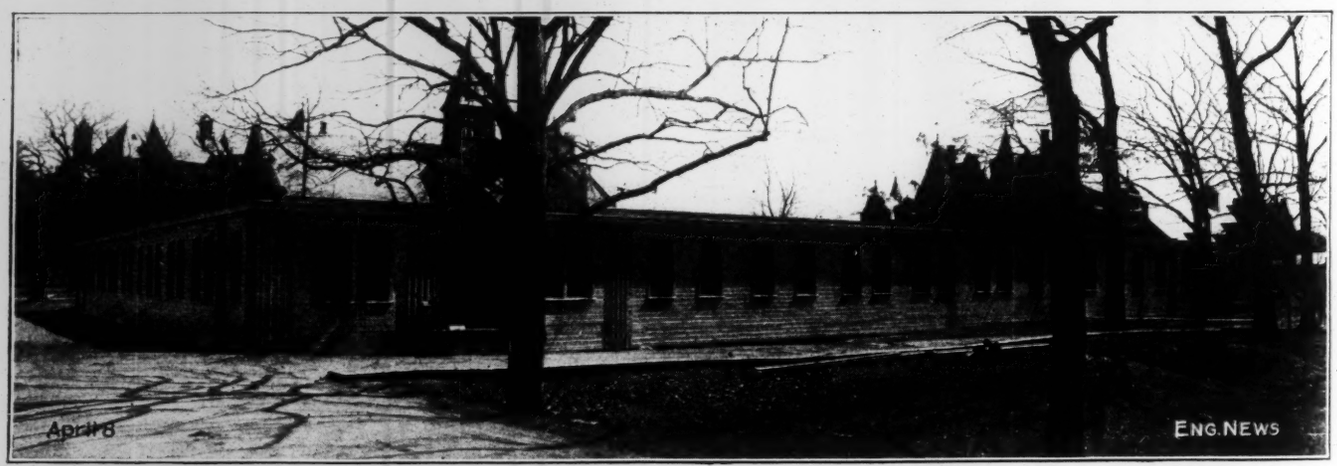
Field and Office

Fast Erection of a Temporary Frame Administration Building for Wellesley College

The erection of a large one-story wood building, to be used as a temporary administration and lecture hall, at Wellesley College, Wellesley, Mass., was commenced on Mar. 27. Twelve days later the building was completed and ready for occupancy.

The new building will take the place of College Hall, the main building of the college, which was burned on Mar. 17. At the end of two years, it is intended to re-





PROGRESS OF CONSTRUCTION OF LARGE ONE-STORY FRAME BUILDING

place the temporary structure with a permanent one. The temporary building is 250x60 ft., with two wings about 100x42 ft. each, making 23,400 sq.ft. of floor space. The building is set on 260 cedar posts, and is equipped with hardwood floors, steam heat, and electric light. It is divided into 66 rooms.

Incorporated in the construction are 200,000 ft. b.m. of lumber, 25,000 ft. b.m. hard-pine flooring, 210 sq.yd. of asphalt roof, 40,000 ft. of Cabot's quilting for wall lining, and 75,000 ft. b.m. of wall boards. All window frames and sashes are double hung and made especially for this job; while all interior trim is special, of hard pine. The doors are of fir, stained to mahogany color; the floors are oiled and waxed.

The working force consisted of 116 carpenters, 10 roofers, 8 plumbers, 24 steamfitters, 20 painters, 25 laborers, with superintendents and foremen. Work was stopped one day on account of rain, while for one and one-half days only inside work was possible, for the same reason. The three photographs show the speed with which the work progressed. The object in pushing the building rapidly to completion was in order to have it habitable when the students returned from vacation on Apr. 7.

The cost of the building, including the heating apparatus connected with the main heating plant of the college a quarter-mile away, was about $32,000. It is said that when the temporary building is taken down the material will salvage for 50% of its value new. The contract was awarded to the George A. Fuller Co., Boston, Mass., on Mar. 26.

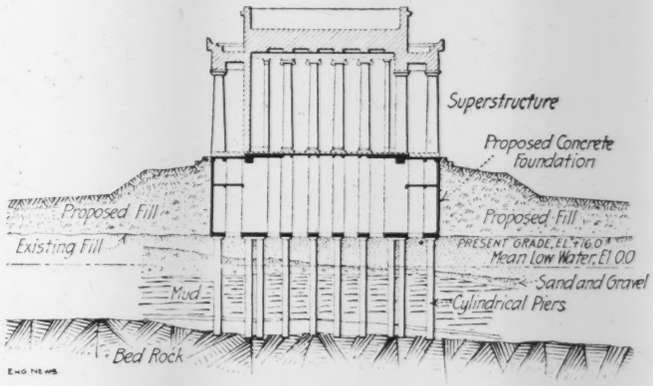
Cylinder-Pier Foundations for Lincoln Memorial, Washington, D. C.

By W. W. Harts*

The Memorial to Abraham Lincoln, which was authorized by a recent Act of Congress, has just been commenced in Potomac Park, Washington, D. C. The Memorial will be a temple of pure Greek design, constructed of white marble, of great simplicity and beauty. It was designed by Henry Bacon, of New York. The total cost will be $2,000,000. The contract for the superstructure has been awarded to the George A. Fuller Co., of New York, and the contract for the foundations and substructure has been let to M. F. Comer & Co., of Toledo, Ohio.

The superstructure is to be carried, through the medium of a concrete substructure, on a number of reinforced-concrete piers reaching down to bedrock, from 42 to 56 ft. below the present surface (see the accompanying drawing). These piers are to be sunk by the cylinder-pier method, that is by excavating inside of weighted steel cylinders and adding upper sections to the cylinder as it sinks under the weight.

Work on the foundations is now under way, the first cylinder having been sunk to a depth of 50 ft., although not entirely to its final position on bedrock. Several others have been partially sunk. The foundation will consist of 122 of these steel cylinders from 3 ft. 6 in. to 4 ft. 2 in. in diameter, composed of ½-in. steel for the bottom 20 ft., and ⅜-in. steel for the remainder. These cylinders, after reaching rock, are to be filled with 1:2:4 concrete reinforced by twelve 1¼-in., twisted steel rods (1 in. used in 3 ft. 6 in. cylinders), held in place by a spiral of ¼-in. diameter steel with a 1-ft. pitch. The



Section through Lincoln Memorial, Washington, D. C., Showing Foundations

lowermost part of the column will be set into the rock a distance of 2 ft., the reinforcement being extended into this portion.

Thus far the cylinders are being sunk with very little difficulty, the process being simple and effective. A hole is dug 10 or 12 ft. deep in which frames are placed for plumbing the cylinder. A section of 20 ft. is placed vertically in these frames, held in place by the frames, and then 10 to 20 tons in weight composed of concrete blocks are placed on the upper edge, sinking it through the soil with the aid of a water jet. When the cylinder has ceased to sink, the interior is cut out with an ordinary four-pronged orange-peel bucket of 2.7 cu.ft. capacity, and the weight again applied.

The first cylinder has been sunk 50 ft. without difficulty. The material through which it penetrates is mainly clay and almost impervious to water, making the leakage slight. Should this favorable condition be found at lower depths and over the whole area it may not be necessary to use compressed air in excavating the rock at the bottom. This method of foundation, although not new in engineering practice, is more or less unusual in Washington for public buildings, so that the sinking of the cylinders is attracting considerable attention.

*Colonel, U. S. Army, Lincoln Memorial Commission, Washington, D. C.

Layout Survey for Des Moines River Viaduct—The Des Moines River viaduct of the Chicago, Milwaukee & St. Paul Ry., three miles west of Madrid, Iowa, is 2394 ft. long and 130 ft. in maximum height. It consists of 40-ft. tower spans, 70-ft. intermediate spans, and two 155-ft. truss spans across the river. Most of the concrete pedestals are supported on piles. The layout work was done by means of repeated horizontal measurements with a 100-ft. steel tunnel tape. A spring balance was used and the tape was supported every 33 ft. Corrections were made for temperature. At each measurement point an 8-in. oak post 5 ft. long was set in the ground and a zinc plate tacked on top. This enabled the establishment of an accurate and permanent point. Independent lines were run, establishing the 100-ft. stations, and the bents were checked from these points. At the end, close measurements were also taken as a check. Much of the measuring was done at night in order to secure the benefit of a more even temperature. The layout provided for a normal temperature of 70°. Concrete benchmarks extending 5 ft. into the ground were placed so that direct readings could be made from benchmark to every pedestal, and these were checked independently by three sets of levels, run at different times by different men, there being no greater variation than 0.008 in. between the different elevations at any bench mark. [J. H. Prior, Engineer of Design, C. M. & St. P. Ry.]

Making Concrete Blocks for Kensico Dam

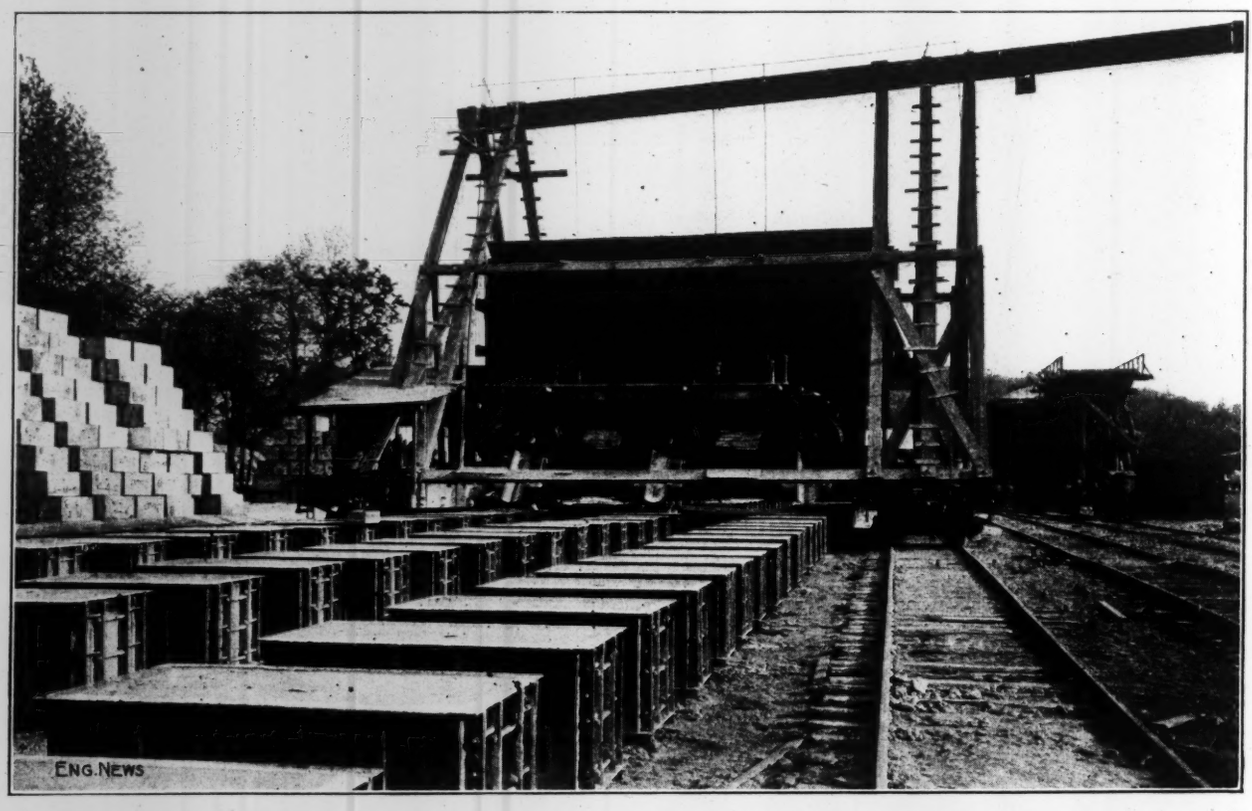
By Wilson Fitch Smith*

The upstream face and the expansion joints of Kensico Dam, for the Catskill Water System for New York City, are faced with concrete blocks which are laid (with 1-in. mortar beds and joints) in advance of the cyclopean masonry forming the mass of the dam, thus serving as forms for the latter.

These concrete blocks are made in a special plant set up a short distance below the dam. This consists of a yard 1100 ft. long, through the center of which runs a traveling platform spanning three rows of special steel forms. The traveler carries three 1-cu.yd. rotary mixers, one over each line of forms, into which they discharge directly. The mixers are supplied with materials from overhead bins carried on the traveler, which are supplied by a telpher operating on a cantilever beam, which handles bottom-dump buckets containing the aggregates, from trains of flat cars on a track parallel to the traveler tracks. The hoist which operates the telpher supplies the motive power for moving the traveler. Cement is supplied directly from the freight cars placed alongside the traveler.

The blocks are all cast with the exposed face down. Each shape of block has its own set of forms. The forms are entirely of steel and consist of a bottom or bedplate and four sides fastened together by bolts through the flanges. The blocks for the expansion joints consist of two shapes; plain rectangular blocks, which are used in the grooves alternately as headers and stretchers, and rectangular blocks on which the faces of one end and one side are beveled 1 in. for a depth of 1 ft., used in the tongues either as headers or stretchers in such a manner that the beveled faces form the sides of the tongue. These blocks are 5 ft. long, 2 ft. 5 in. high and 2½ ft. thick. Special tongue blocks 6 ft. long, having one end tapered and a recess in one face of the taper for the reception of the copper strip which forms the water stop, are used near the upstream face adjacent to the inspection well.

For the upstream face of the dam, the blocks are arranged in alternate header and stretcher courses, one size header and three sizes of stretchers being used to obtain the bond. The arrises of the upstream face blocks are finished with a radius of 1 in. This is formed by the shape of the bed plate. Bond grooves are formed in the top bed and builds of face blocks. These latter afford spaces for the specially shaped chain dogs by which the blocks are handled. The expansion joint blocks have small recesses formed for the chain dogs.



Concrete Block Plant for Face Stone on Kensico Dam

The concrete is mixed in the proportions of one part cement, three parts fine aggregate and five parts coarse aggregate, which is mixed to a plastic consistency. About 6 in. is placed in the bottom of the form and then carefully worked with spacing forks to procure a smooth mortar surface. A layer of from 6 to 8 in. of concrete is then added and carefully worked, the process being repeated until the form is filled, when the top is screened off, and after the concrete has set slightly the block letter and date are marked on the soft concrete. The resulting blocks are very dense and homogeneous. Tests show an absorption of less than 5% by weight. The surfaces of the forms are smeared with petroline or crude vaseline thinned with kerosene. The faces are smooth and dense and require no further finish. After the concrete has set

*Division Engineer, Board of Water Supply, New York City, Valhalla, N. Y.

sufficiently, the side forms are removed; usually within 24 hours during warm weather. After a further hardening, usually from two to three days, they are picked up, turned on their beds and placed in storage piles by traveling derricks, where they are allowed to set for at least 30 days. During warm weather they are sprayed with water.

The steel forms are rigid and tight and have given no trouble from bulging or distortion, which so often occurs when wooden forms are used repeatedly.

This plant has proved very successful and economical. 29,160 cu.yd. of blocks have been made during the past season, the best day's output being 271 cu.yd.

A Neat Test-Method for Bearing Power of Wood

In recent tests at Rose Polytechnic Institute on the bearing power of wood on faces inclined to the grain, a neat test-method was employed. The apparatus is simple, comprising little more than a special crushing die fitted with micrometer for measuring indentation. The shape of test-piece and the routine of the test are such as to give a maximum of results at small effort, and at the same time secure an unusual degree of reliability.

The test-piece and the layout of test center-lines on the piece are shown in Fig. 1, together with the cradle

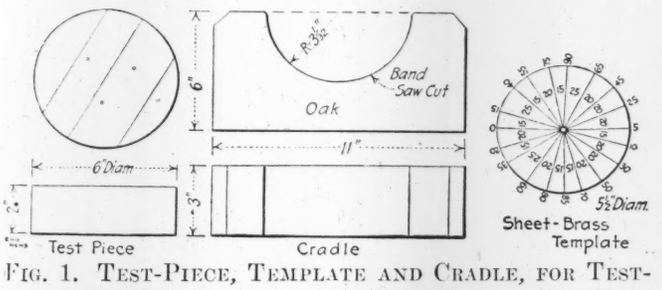


FIG. 1. TEST-PIECE, TEMPLATE AND CRADLE, FOR TESTING BEARING POWER OF WOOD ON INCLINED CUTS

(Testpiece cut out of 8x16-in. block with band saw. Turned with sharp chisel, no scraping or mashing, no sand paper. Remainder of block split to determine grain.)

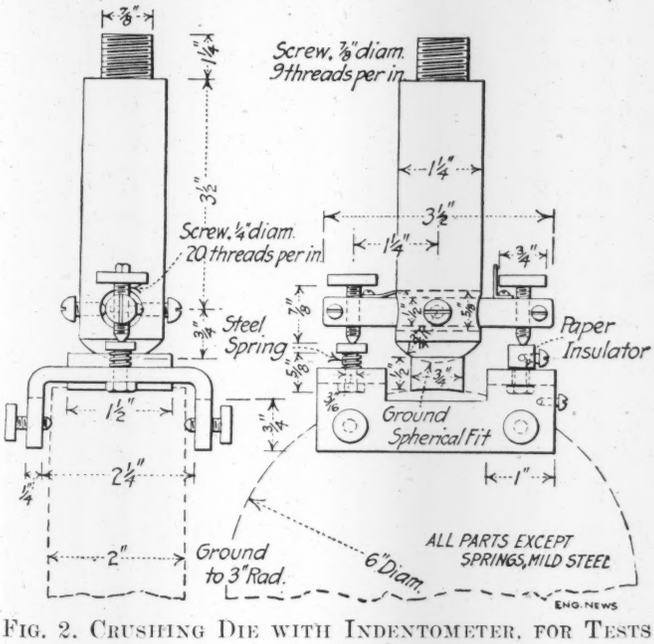


FIG. 2. CRUSHING DIE WITH INDENTOMETER, FOR TESTS OF BEARING POWER OF WOOD ON INCLINED CUTS

which supports the piece during the test. A large number of different tests is made on the same piece, all at different angles to the direction of grain. Thus, for each particular kind of wood, an entire series (a test for every 5° from 0° to 90°) is made on a single test-piece, which eliminates all variations due to differences of separate samples. The curves of test results obtained are unusually consistent, probably due to this fact.

The testing die is shown by Fig. 2. The die block is 1½x¾ in. on the pressure face, which is ground to 3-in. radius to fit the outside of the test-piece. The micrometer screws are fitted with electric connections, with bell to denote the moment of contact of the measuring screw (right-hand screw) with the yoke.

The tests were made under Prof. Malverd A. Howe. The apparatus was designed by Prof. H. A. Thomas. We will shortly quote the results obtained in the latest tests made with the apparatus.

Compensating-Chain Adjustments for Short Lengths

By H. H. Claxton*

Accurate city measurements are almost invariably taken with a 50-ft. compensating spring-balance chain.† Usually these chains are divided into lengths of 20 ft., 25 ft. and 30 ft., for the purpose of taking shorter measurements over rough ground. If these short measurements are frequent, it becomes especially necessary to have a correct compensator scale setting for temperature. As the divisions on the compensator are graduated for a 50-ft. length, a reduction is necessary in each case for the 20-, 25- and 30-ft. lengths. I use the following method for determining these reductions. It consists in first standardizing for each of the short lengths, and then reducing *pro rata* from the standard for temperature changes.

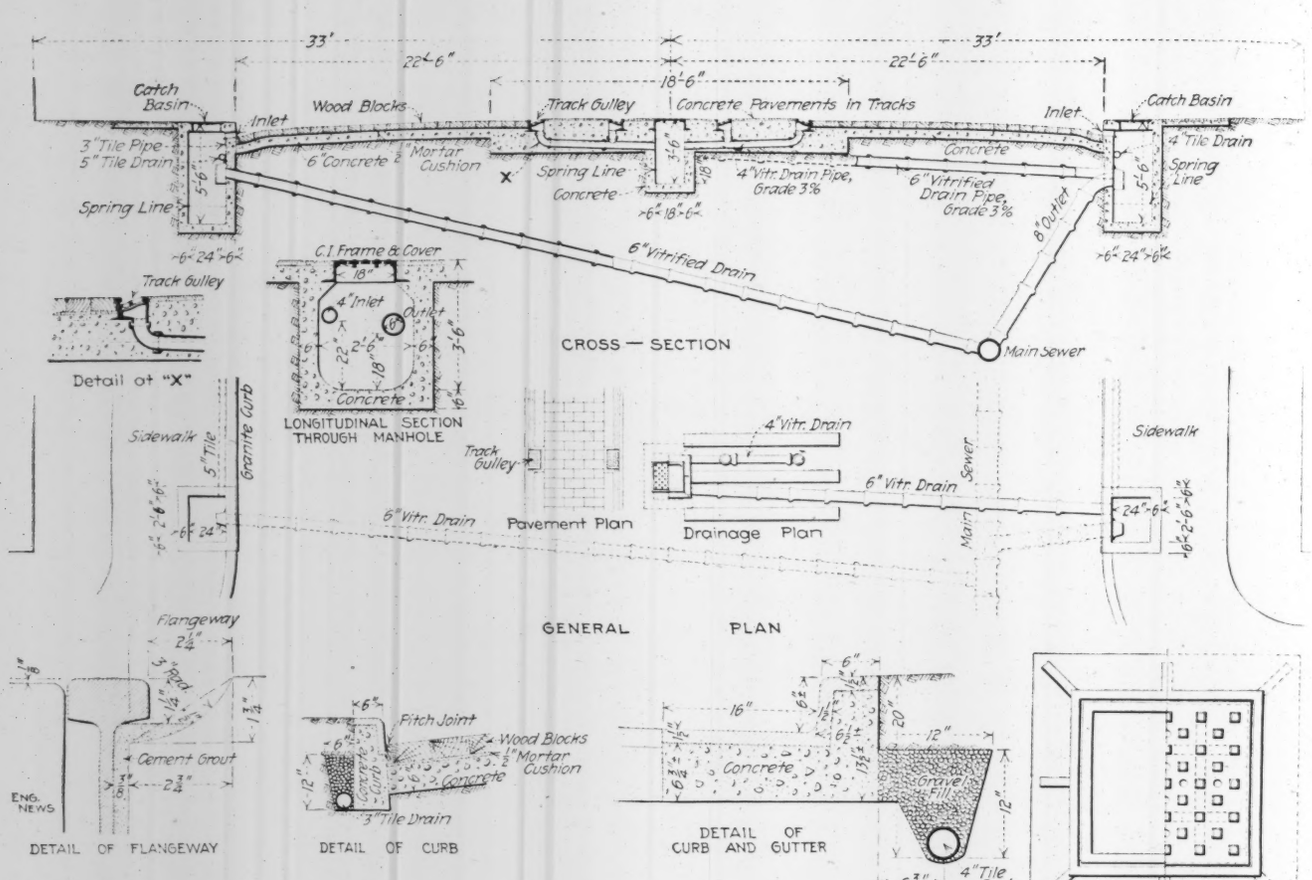
Taking the 25-ft. length first, as being the simplest: having first compared the 50-ft. length with a standard, lay off one 50-ft. length. Suppose the temperature is 60° F. Using this temperature setting on the compensator scale, apply the 25-ft. length once on line. For the second length, set the compensator at the necessary position to check on the 50-ft. point. Suppose the necessary setting is 50° F. It is evident that the setting for the 25-ft. length is 5° too high.

Setting the compensator at 55° F. and applying the 25-ft. length twice, the measurement should agree with the 50-ft. length. Since the 50-ft. length varies twice as much as the 25-ft. length, it is evident that if the temperature fell to 50° F. the setting for both 25-ft. and 50-ft. lengths would be the same at 50°. The setting for any other temperature must be referred to this. Thus, if the temperature rises to 90°, the setting for the 50-ft. length is 90°; but the 25-ft. length varying only half as much, the correct setting would be 50° + (90° — 50°) ÷ 2, or 70° F.

For the 30-ft. length, lay off 150 ft. on a straight line. Suppose the temperature to be 60° F. Use this temperature setting for four 30-ft. lengths, and then set the

*Civil Engineer, 285 E. 161st St., New York City.

†A fine flat steel wire tape with special spring balance carrying a spirit level and thermometer and scale, for adjusting the length to make the tape standard at any temperature.



CROSS-SECTION, PLAN AND DETAILS OF PAVED-STREET DRAINAGE SYSTEM, VANCOUVER, B. C.

compensator for the fifth measurement to agree with the 150-ft. point. Suppose the necessary setting is 110°. The setting for the 30-ft. lengths is 10° too low, as shown on the compensator. Assume divisions of one degree on compensator. With every degree of rise in temperature above 60° the 50-ft. length gains two-fifths of one of these divisions over the 30-ft. length. Hence to gain one division, the temperature must rise 2½°, and to gain 10° there must be a rise of $10 \times 2.5 = 25°$. Hence the setting for the 50-ft. and the 30-ft. lengths is the same at $60 + 25 = 85°$ F. = standard for 30-ft.

If the temperature falls to 40°, 40° will be the setting for the 50-ft. length, but for the 30-ft. length the fall on the compensator will be represented by $(85° - 40° = 45°) \times \frac{3}{5} = 27°$. Hence, $85° - 27° = 52°$, will be the setting for the 30-ft. length.

For the 20-ft. length lay off 100 ft. and use the same method, remembering that the change in 20 ft. is $\frac{2}{5}$ths that of 50 ft.

The 50-ft. chain itself may not be exact, that is, it may be necessary, for example, to set the compensator 10° higher or lower than the true temperature to agree with the chain standard. As our short lengths are compared with exact distances on the ground, this constant error in the 50-ft. length will not affect the method. The true temperature is always used. The tension does not enter either, it being also a constant.

Grading Tools for Road Work—Slip scrapers will be found to be the best tool to move dirt distances up to 75 ft., wheeled scrapers from 75 to 300 ft., wagons (preferably dump-wagons) for distances over 300 ft. [Wisconsin Highway Commission's "Instructions to Foremen."]

Street-Drainage System, Vancouver, B. C.

The accompanying plan and details show a method of street drainage adopted in Vancouver, B. C. The plan is practically self-explanatory. This system has been used with success in the paved business streets, although it is costly, as is readily seen from the details.

As originally planned and constructed, the track drainage was provided for by 8-in. gullies on the inside of each rail, formed of a cast-iron box with removable top, as shown in the accompanying plan, but without the center pit and manhole. Considerable difficulty was experienced in keeping the track gullies clear, and unless they were frequently watched it was almost impossible to keep the track drainage in operation at all. Accordingly, the change was made to the method of construction shown.

The sump in this chamber is designed to take care of a considerable amount of mud and refuse, which of necessity must find its way into these track gullies. The area of the track gullies was also enlarged, allowing for a greater waterway. It was also possible to dispense with the trap in the track gully by adopting the central-chamber design.

This design was made and the work carried out under the direction of F. L. Fellowes, Supervising City Engineer.

Concreting Pedestals for New Steel-Plant Buildings

The Otis Steel Co. has now in course of construction in the upper Cuyahoga River Valley at Cleveland, Ohio, a new steel plant covering some 230 acres and including a great number of buildings. Practically all the columns for these buildings are founded on prismatic concrete pedestals about 12 ft. square at the bottom, 6 ft. square at the top, and 15 to 20 ft. high. In all, 400 of these pedestals have been or are to be built in the whole plant and scattered over its entire area. This does not include mill, conveyor and furnace foundations, which are also of concrete. The great number, wide distribution, and small cubical contents of each pedestal involved considerable difficulty in the design of an economical concrete placing plant. The problem was solved by using a pneumatic concrete mixer located at about the middle of the plant's area and blowing the mixed concrete through pipes to each individual pedestal.

Fig. 1 shows the pedestals for one of the buildings with the mixing plant in the right background. This

FIG. 1. CONCRETE PEDESTALS FOR BUILDINGS OF NEW STEEL PLANT, OTIS STEEL CO., CLEVELAND, OHIO.

FIG. 2. GOOSENECK DELIVERY END ON PNEUMATIC CONCRETE MIXER, OTIS STEEL PLANT

plant comprises a material bin, mixing hopper and pneumatic mixer. It is approached on either side by railroad tracks on which is run a locomotive crane which loads the material bin with the sand and stone as required. The bins draw off into an open hopper which contains the sand, stone and cement, from which the material is dropped into the compressed-air mixer below. Leading out from the mixer is an 8-in. pipe flanged in 10- to 14-ft. lengths, which may be laid along the ground to any part of the plant.

Fig. 2 shows the delivery end of the pipe. The device is merely a goose-neck of 8-in. pipe supported by a timber frame and carried on a pair of skids, which may be pulled on the ground or upon rollers. The bottom of the goose-neck connects with the elbow joint to the 8-in. delivery pipe from the mixer. The goose-neck revolves on a radius of about 12 ft. through an angle of 270°. It can be raised or lowered so that it delivers immediately above the top of the pedestal form. This goose-neck is pulled from pedestal form to pedestal form and the pipe to the mixer is lengthened as required by inserting extra pipe lengths.

The concrete aggregate used in this work consisted of river sand and crushed screened slag. The proportions of mix ran 1 part cement, 3 parts sand and 5 parts crushed slag. The slag proved admirable as aggregate, except at first a quantity of large lumps together with pieces of pig proved hard for the mixer to handle. Care in screening removed these and afterward no trouble was had. The mixer carries a ¼-cu.yd. batch. It has been used to a maximum length of 700 ft. and a maximum

elevation of 30 ft. In all, during the past year, 26,000 cu.yd. of concrete have been placed in the pedestals of the plant. This mixer has varied in producing capacity ranging from 150 to 300 cu.yd. per day of 10 hours.

The mixer and conveyor was furnished by the Concrete Mixing and Placing Co., of Chicago. The work of construction is being carried out for the Otis Steel Co., by P. T. McCourt, contractor, of Akron, Ohio.

plied, a hole 12 in. square was dug down about 2 ft. ... tant from the loading post, and the bottom of this hole was carried to the same elevation as the bottom of the post. Water was also poured around the loading post at the maximum load (unless there was water in the pit at the time), the idea being to saturate the soil and find out the effect of moisture on it under load.

Settlements were measured by stretching a fine wire...

FIG. 1. RIG FOR LOAD TEST ON FOUNDATION SOILS

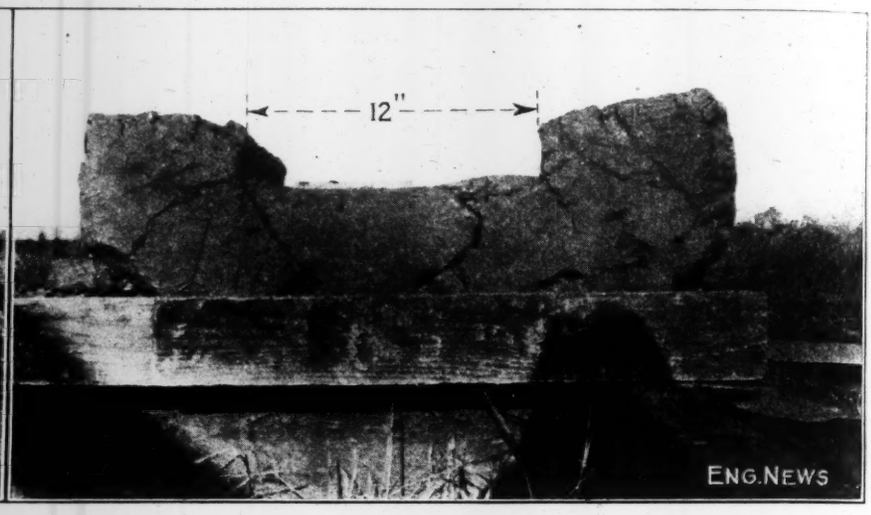


FIG. 2. VERTICAL SECTION OF CLAY UNDER LOADING POST, AFTER TEST

Load Tests on Sand and Clay Foundation Soils

BY M. W. MANZ*

The Chicago & Erie R.R. Co. has been making preparations for the construction of a new coal-storage plant at Highland, Ind., the plant to have a capacity of about 150,000 tons. The bearing power of the soil was very uncertain, and tests were made to determine whether it would be safe to place the footings directly on the soil or if it would be necessary to resort to piling, and to give definite data for the design of soil footings.

The tests were made on all of the important strata of subsoil found at this place. The method of procedure was to support a 12x12-in. timber vertically, as illustrated in Fig. 1, so that it had unimpeded vertical motion. The end of the timber was dressed to exactly 12x12 in. After the post and platform had been placed, loads were applied from day to day in increments of about 2000 lb., and the post was allowed to stand under each load till settlement had apparently ceased or until it did not seem advisable to hold the test up longer. The material used for loading was pig iron and short rails.

Most of the loads in the coal-storage plant will be vibratory in their nature, and because of this the post was pushed strongly from time to time to set up a motion of vibration or oscillation. This motion was exaggerated in comparison to any vibration that would in all probability take place, and it will be noticed by the curves that each time the post was oscillated settlement took place.

In each test, after the maximum load had been applied, a hole 12 in. square was dug down about 2 ft. distant from the loading post, and the bottom of this hole was carried to the same elevation as the bottom of the post. Water was also poured around the loading post at the maximum load (unless there was water in the pit at the time), the idea being to saturate the soil and find out the effect of moisture on it under load.

Settlements were measured by stretching a fine wire taut between two stakes set on opposite sides of the loading post (so that the wire just cleared one face of the post by about ¼ in.), and reading the height from the wire to two nails set in opposite edges of the face of the post along which the wire was stretched.

KINDS OF SOIL

Five different soils were tested, as follows:
Grayish-blue clay.
Gray water sand 1 ft. deep over the clay.
Gray water sand 7 ft. deep over the clay.
Yellow sand.
Mixed sand and gravel.

The soil stratification at the two places where tests were made is shown in Fig. 3. The above soils lie be-

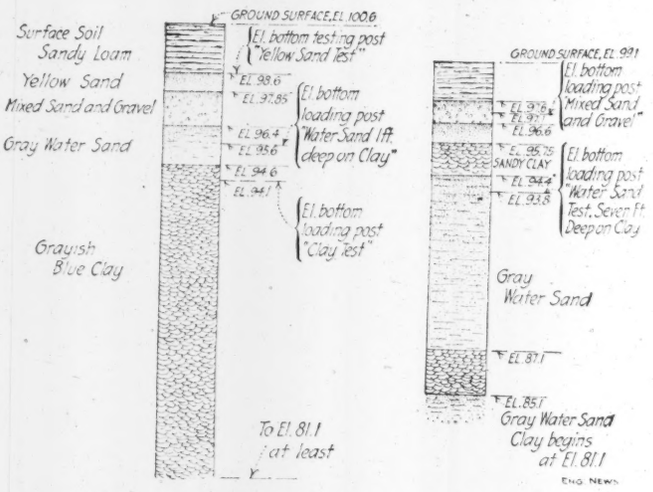
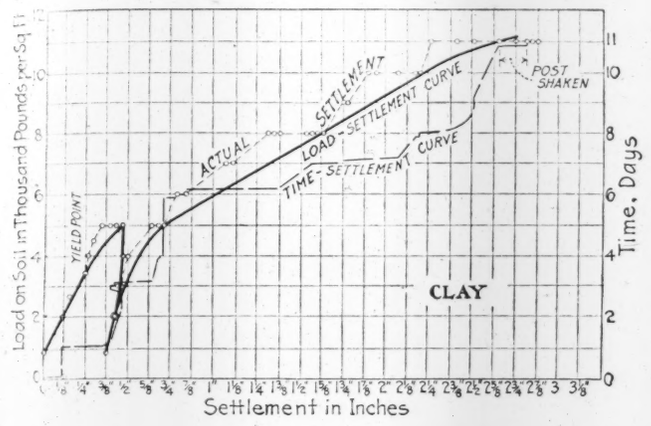


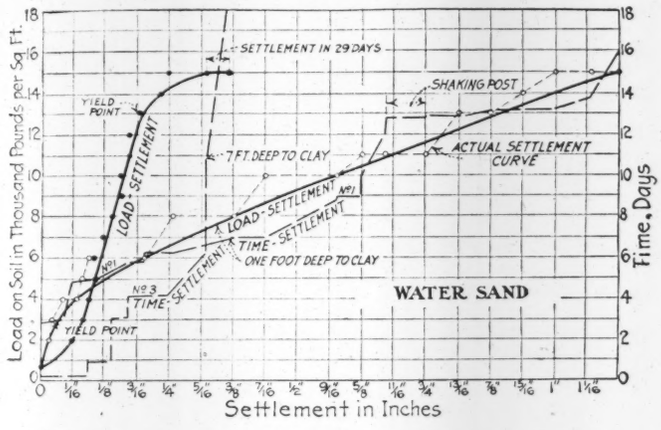
FIG. 3. STRATIFICATION OF SOIL AT TEST LOCATIONS

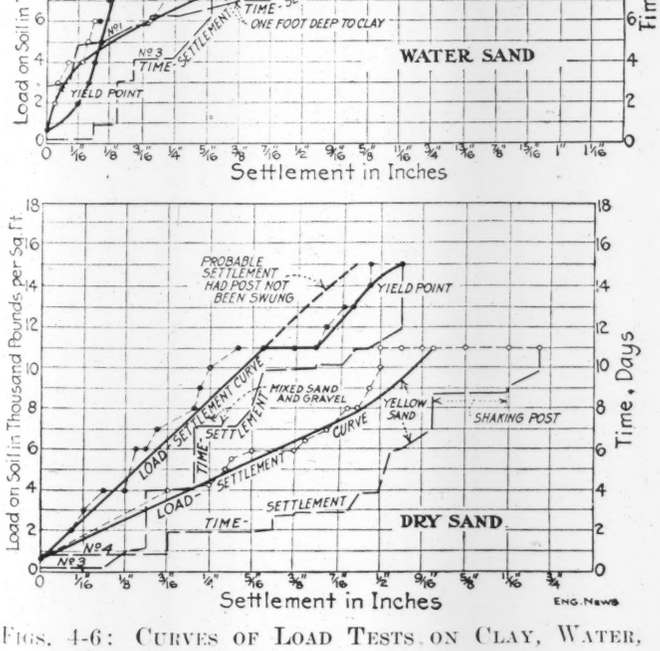
*Chicago & Erie R.R. Co., Huntington, Ind.

for the surface in strata varying in thickness from 6 in. to 4 or 8 ft., except the clay, which is in a bed probably 50 ft. thick.

This clay is a slightly moist grayish-blue soil. When being excavated it had a blue appearance and was so tough that it was difficult for a man to work with a shovel. Upon application of hydrochloric acid there was an effervescence that was quite pronounced. After the







FIGS. 4-6: CURVES OF LOAD TESTS ON CLAY, WATER, SAND AND DRY SAND

clay had been exposed to the air for a few days it gradually turned to a very light gray and became extremely hard.

LOAD TEST ON CLAY

To make the test with the pit in a thoroughly dry condition, Wakefield sheet piling was driven and the bottom of the pit was covered with 2x6-in. flooring, well braced, to prevent any rising of the clay.

As shown by Fig. 4 the load was removed from the post when a load of 5000 lb. had been reached. The object of this was to find out the amount of settlement that would be recovered. The settlement regained was 20% of the settlement up to that time.

After a load of 11,000 lb. had been applied a hole 1 ft. square was opened in the corner of the pit. The clay pushed up in this opening about $\frac{1}{16}$ in. the corner nearest the post, running to zero near the wall, while the post settled $\frac{1}{64}$ in. almost at once and another $\frac{1}{64}$ in. within an hour.

Fig. 2 shows the manner in which the post sank into the clay. This was a piece of the clay cut from its position directly under the post. The cracks were made in handling the specimen, but the true profile of the section had not been altered and it is interesting to note that the soil yielded much as a sheet of rubber would, before the post began to punch into it. The surface of the clay sank down near the post but punched up a foot or two farther back, as shown by the way it shaped itself to the flooring.

TEST ON WATER SAND

The water sand was a gray, round, fine sand lying below the mixed sand and gravel. This sand was always moist and generally wet. It was rather compact, but when cut below the water level the water flowing into the pit carried the sand with it. To avoid this difficulty, boxing was built around the post to prevent any saving. This boxing was just large enough to clear the post, and the sand was backfilled around it after it had been placed.

During both of the tests on water sand there was water around the post at all times, being about $\frac{1}{4}$ in. deep in the test where the sand was 1 ft. deep over clay, and 6 in. in the other test. A hole was opened near the post, as already described, but there was no evidence of any punching up of the soil or any additional settlement of the loading post.

Fig. 5 shows that the maximum settlement was $\frac{41}{128}$ in. for a load of 15,000 lb., where the sand was 7 ft. deep over the clay. After the date for which this point was plotted the post stood for one month (Nov. 12 to Dec. 11, 1913). During this time the post settled to $\frac{47}{128}$ in.

TESTS ON DRY SAND

The yellow sand was a fine sharp sand with a discoloration of iron ore appearing in it at times.

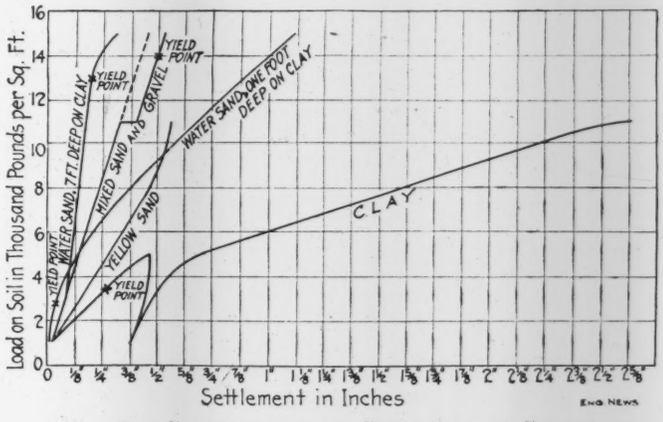

Load on Soil in Thousand Pounds per Sq. Ft.
Settlement in Inches
YIELD POINT
WATER SAND, 7 FT. DEEP ON CLAY
MIXED SAND AND GRAVEL
WATER SAND, ONE FOOT DEEP ON CLAY
YELLOW SAND
CLAY
ENG. NEWS

FIG. 7. COMPARISON OF SETTLEMENT CURVES

The mixed sand and gravel was composed of a coarse brownish sand and gravel. It was rather hard and could not be easily shoveled without first loosening it up with a pick. The curves for these sands are shown in Fig. 6.

When the hole was opened near the posts there was no evidence of any additional settlement or any rising of the sand in the open hole. The application of water did not affect the mixed sand and gravel, but did cause additional settlement of the post on the yellow sand.

Comparison of Results

For purpose of comparison the curves have been plotted together in Fig. 7, where can be seen at a glance the merits of the various soils as far as settlement is concerned.

The results obtained are tabulated below.

Soil	Yield-point in lb. per sq.ft.	Total load in lb. per sq.ft.	Total settlement in.	Settlement recovered on unloading, in.	% of total settlement recovered on unloading
Mixed sand and gravel	14,000	15,000	$\frac{17}{32}$	$\frac{1}{4}$	14.7
Water sand—fairly deep beds	13,000	15,000	$\frac{47}{128}$	$\frac{11}{128}$	23.4
Water sand—shallow bed on clay	2,700	15,000	$1\frac{1}{8}$	$\frac{3}{16}$	16.67
Yellow sand	questionable	11,000	$\frac{47}{64}$	$\frac{3}{64}$	6.4
Clay—grayish blue	3,400	5,000	$\frac{15}{32}$	$\frac{3}{32}$	20.0
		11,000	$2\frac{7}{8}-\frac{3}{8}=2\frac{4}{8}$	$\frac{3}{16}$	7.5

The following conclusions can be drawn:

1. The sandy soils are by far the best, the coarse well cemented sand and gravel being the most consistent in its ratio of settlement to load, while the water sand in fairly deep beds comes next. The poor showing of the same sand in shallow beds on clay is probably due to the sand punching down into the clay.

2. Clay of the nature tested has a very low bearing value.

3. The settlement regained in soils when the load is removed is small compared to the total settlement.

The tests were made in accordance with general methods suggested by R. C. Falconer, Superintendent of Construction, Erie R.R. Co., and were under supervision of W. J. Foster, District Engineer, Chicago & Erie R.R. Co. The writer had charge of the work on the ground, carrying on all the work and making the reports.

Razing a One-Story Reinforced-Concrete Building

By Jay C. Lathrop*

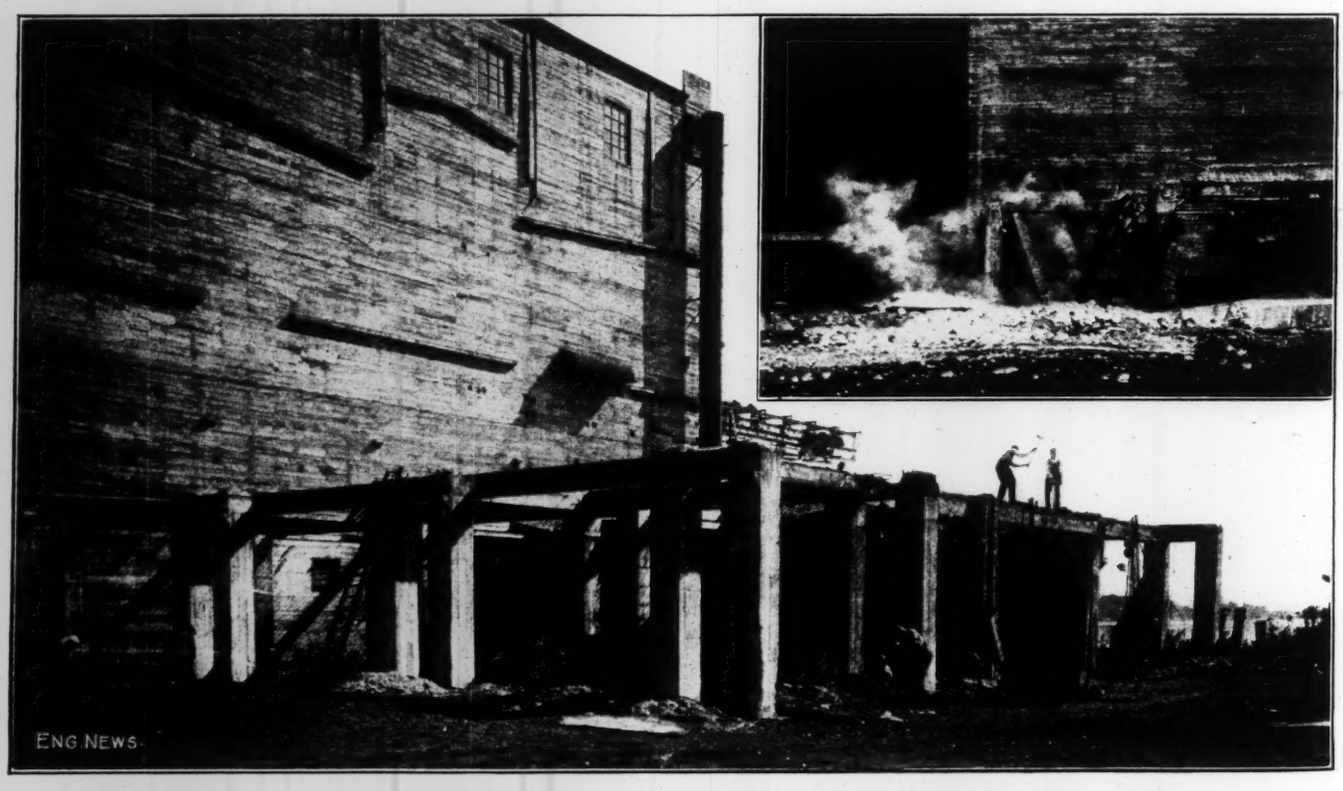
A few months ago during the construction of a new boiler house, the Consolidated Gas, Electric Light and Power Co., of Baltimore, found it necessary to remove a structure containing about 300 cu.yd. of reinforced concrete. As shown by one of the accompanying views, this building had been carried up one story, and consisted of 35 columns together with the first-floor girders and slab, and a number of ash hoppers, partition walls, etc.

Twelve of the columns were 12x36 in. in section and were reinforced with eight 1¼-in. round bars with ties at one-foot intervals. The rest of the columns were 24 in. square, reinforced with eight 1-in. round bars. The girders were also heavily reinforced, while the floor slab reinforcement consisted of ⅜-in. round bars 5 in. c. to c.

This structure was erected about six years ago, and the concrete was very hard. A local contractor undertook to demolish this building and remove all débris to another part of the company's property, where filling was required.

The methods adopted for carrying out this work were

*Consolidated Gas, Electric Light & Power Co., Baltimore, Md.



Figs. 1-2. Tearing Down a One-Story Reinforced-Concrete Frame
(Fig. 2, inset, shows a blast at base of column.)

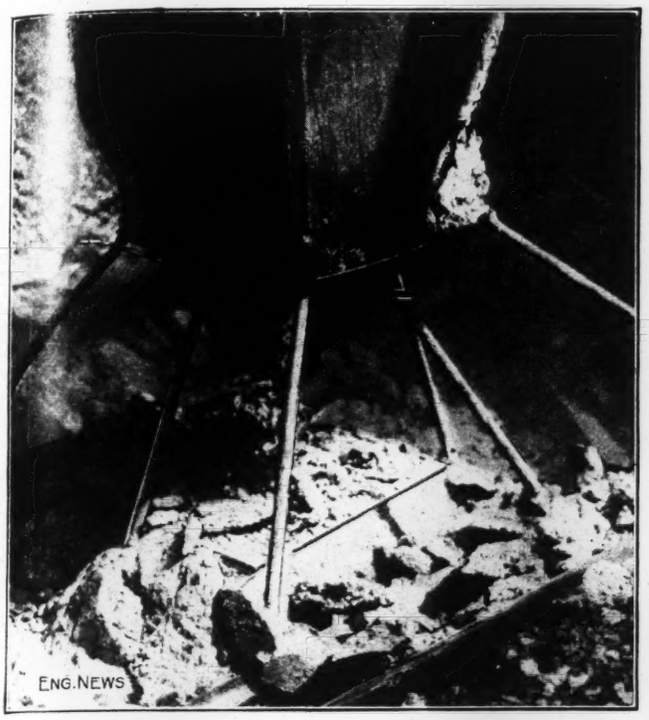


FIG. 3. APPEARANCE OF BASE OF COLUMN AFTER BLAST

as follows: The floor slab and ash hoppers were broken out by hand, as shown in Fig. 1. Laborers with sledges accomplished this part of the work in a short time. When it came to the girders and columns, light charges of dynamite were used at the tops and bottoms of the columns, allowing the girders to fall to the ground where they were broken up, in some cases by hand, and in others by dynamite. Fig. 3 shows the effect of a charge which was placed at the base of a column. The manner in which the vertical rods were placed resting on a steel plate is clearly shown in this view. It is probable that this arrangement simplified the destruction of the column, for if the reinforcing bars had been extended into the column footing, it would have been necessary to saw them off.

The contractor agreed to do this work in 20 working days and succeeded in completing it within a total of 23 working days.

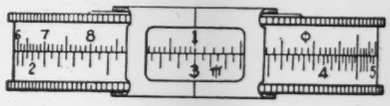
The cost to the contractor was about $1200, or about $4 per cu.yd.

NOTES

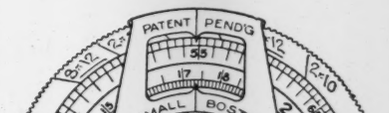
Triangulation Work with a Motor Truck—C. V. Hodgson, Assistant, United States Coast and Geodetic Survey, is about to make a tour of the southwestern part of the United States for the determination of the astronomic latitude of triangulation stations between Barstow, Tex., and the Pacific coast. Many of these stations are on mountains as much as 10,000 ft. in height. The means of transportation for Mr. Hodgson's party will be a 1½-ton automobile truck, which was used successfully on similar work between Denver, Colo., and the Canadian border in the season of 1913. A similar truck had been employed also in 1912 on the 49th parallel boundary survey between the United States and Canada. The cost of the work during the season of 1913 is estimated as only one-half what it would have been if horses and wagons had been used for transportation. The saving in the coming season is expected to be even greater, as the country to be traversed is arid or semiarid and the transportation of water and forage for stock would have been a difficult problem.

In the experience with the truck in 1912 it was found that a field party and its equipment could cover easily from 75 to 100 miles in a day, over indifferent roads, including stops for gasoline, supplies, etc., enroute. The machine will haul this load anywhere that four horses can, and in one-fourth the time. It is equipped with solid rubber tires, dual behind, and with extra tanks for gasoline and water. The weight of the truck is about 6100 lb. and the weight of the equipment of all kinds carried, but excluding the weight of the three passengers, is about 2000 lb., thus bringing the weight of the entire outfit to more than four tons. On the average, 1 gal. of gasoline was used for every 5.2 miles, and 1 gal. of oil for every 61 miles.

A Pocket Circular Slide-Rule for Structural Engineers has been placed on the market by Small, Small & Co., Waltham, Mass. In addition to the common slide-rule graduations, the section moduli of rectangular beams and I-beams are marked on the rule (bottom side, see cut; the scale along the rim gives sizes of rectangular beams, while the inner ring is marked with I-beam sizes, the position of each mark corresponding to the section modulus of the shape. Thus any beam computation is readily made. The section modulus can be read off if desired, or designing can be done direct, by setting fiber-stress opposite total bending moment and noting the size of beam opposite the index.



FRONT



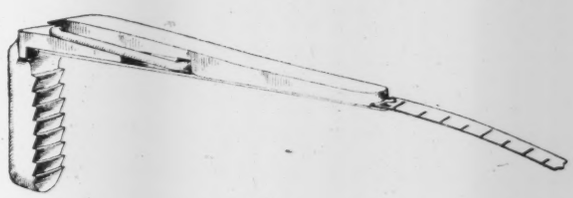
BOTTOM

"SMALL" POCKET CALCULATOR, MODEL 2 (ACTUAL SIZE)

The top side of the rule, which is not shown in the cut, is graduated in three scales; the outside, a 6-in. measuring scale; the middle, reciprocals of numbers on the upper front scale; the inside sines.

This slide rule is produced in two models, of which the one just described is No. 2. Model No. 1 is for general mathematic calculations and omits the structural scales. The price of each model is $6.

Attachable Hook End for Measuring Tapes—The nickel-plated hook shown in the cut can be instantly attached to the loose end of a ¼-in. or a ⅜-in. steel tape. Being serrated, the hook grips firmly the end, or a projection, of the object



to be measured, thus enabling one person to take long measurements. The arrangement is such that the zero point falls exactly inside the hook, giving correct measurement. The tape hook is manufactured by the Lufkin Rule Co., 106 Lafayette St., New York City.

Beam Deflection under Triangular Loading—The query, in this column Apr. 23, as to the location of the point of maximum deflection of beams under triangular and trapezoidal loading, is answered by L. Pistner (Brooklyn, N. Y.). For triangular loading, i.e., loading increasing uniformly from zero at one end to maximum value at the other end, he gives the correct value of 0.52 times the span (nearest the heavier loading). He also points out that under trapezoidal loading the point of maximum deflection must lie even closer to mid-span, since such loading is the sum of a uniform and a triangular load, whose maximum deflections are respectively at midspan and 0.02 the span one side of the center.

The deflection itself he gives as follows: For uniform loading, $0.01302 \frac{Wl^3}{EI}$; for triangular loading, $0.01306 \frac{Wl^3}{EI}$, which is almost precisely the same amount if the total load W on the beam is the same in the two cases. It follows that for trapezoidal loading the maximum deflection will be intermediate between these two values, i.e., for all practical purposes identical with the deflection under uniform loading of the same total amount.

The formula for the exact location of the maximum deflection under trapezoidal loading is of the fourth degree:

$$30\ l^2x^2\ (2\ p_1 + p_2) - 60\ p_1x^3l - 15\ x^4\ (p_2 - p_1) - l^4\ (8\ p_1 + 7\ p_2) = 0$$

where x = distance of point of maximum deflection from the lightly loaded end of the span

l = span

p_1 = load per lin.ft. at light end

p_2 = load per lin.ft. at heavy end.

When p_1 is zero, this reduces to the formula for triangular loading,

$$x = l\sqrt{1 - \tfrac{1}{2}\sqrt{5}} = 0.521\ l$$

On the other hand, when $p_1 = p_2$, the formula gives x = 0.5 l, as it should for uniform loading.

Fuller data for triangular loading (zero at left end of beam, w lb. per lin.ft. at right end) are given by Prof. Wm. R. Bryans, New York University. The total load on the beam is called P, equal to ½ wl.

Reaction at left end

$$= \tfrac{1}{3}\ wl = \tfrac{1}{3}\ P$$

Reaction at right end

$$= \tfrac{1}{3}\ wl = \tfrac{2}{3}\ P$$

Point of max. moment, or point of zero shear,

$$x_1 = \frac{1}{\sqrt{3}}\ l = 0.577\ l$$

Bending moment at any section x from left end,

$$M = \tfrac{1}{3}\ wlx - \tfrac{1}{3}\ w\ \frac{x^3}{l}$$

$$= \tfrac{1}{3}\ Px\left(1 - \frac{x^2}{l^2}\right)$$

Max. bending moment

$$M_1 = \frac{1}{9\sqrt{3}}\ wl^2 = 0.128\ Pl$$

Max. allowable load intensity at right end,

$$w = 1.299\ \frac{f}{l^2}\ \frac{I}{c}$$

Max. safe total load,

$$P = 0.649\ \frac{f}{l}\ \frac{I}{c}$$

Max. deflection occurs at x = 0.519 l.

Max. deflection in inches,

$$d = 11.232\ \frac{wl^4}{EI} = 22.464\ \frac{Pl^3}{EI}$$

In these formulas the span l is in feet, the load-intensity w is in pounds per lineal foot, and the total load P is in pounds.

Time Recording of Successive Machine Operations or those of contractors' tools, is the object of the "Productograph" recently placed on the market by Slocum, Avram & Slocum, 87 Nassau St., New York City. The device is a compact combination comprising a lead-paper roll chart moved by clockwork, on which german-silver needles actuated by electromagnets register the operations by making short tally marks. Connected to machine-shop equipment, concrete mixers, hoists, automatic railway signals, etc., stoppages or failures to operate are readily caught. The device is manufactured in five sizes; the smallest is equipped with two needles (for handling two machines).

What Poor Concrete Construction Means is well illustrated by a report recently made to the Bureau of Public Works, Philippine Islands, on the present condition of a 40-ft. reinforced-concrete arch which was built in the Islands under contract in 1909. The structure is in a bad state of deterioration, the specific defects being given below:

1. The reinforcing bars in the balustrade and outside intrados line of the arch ring are exposed to view in a number of places, and the steel shows considerable rust.

2. In other parts of the balustrade, cracks follow the lines of the bars, admitting moisture and exposing the steel to corrosion.

3. The concrete in the intrados of the arch ring is porous, and has fallen away in places. This is especially noticeable at the outside line of intrados bars, where pockets 3 in. or more in depth are to be found, extending over approximately three-quarters of the length of the intrados.

4. The end posts of the balustrade were plastered over. This is noticeable in the non-uniformity of curves and in the hollow sound when lightly tapped.

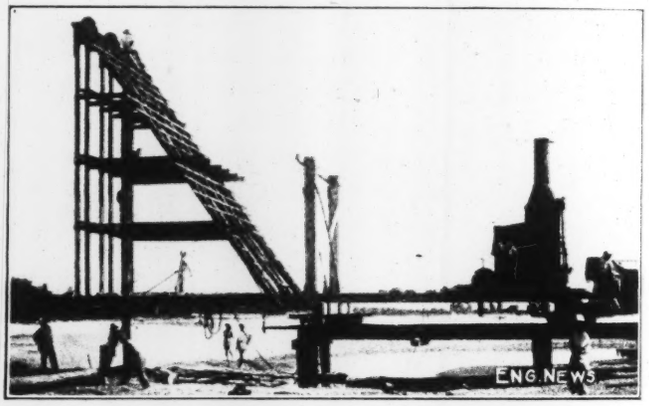
5. The alignment of the balustrade is bad, and wavy lines are much in evidence.

The report further states that the first and second mentioned defects are due to the steel not having been securely fastened in the position called for by the specifications. The specifications for the work state in part:

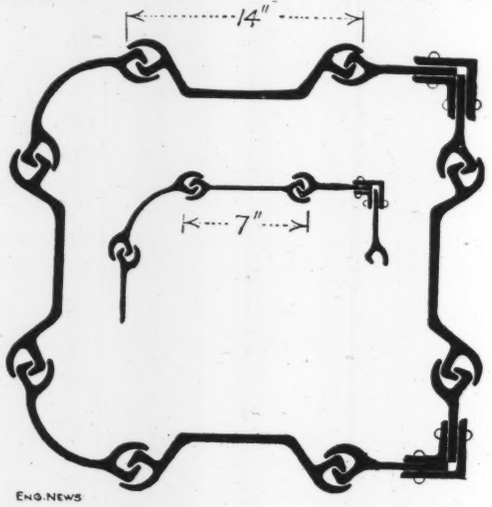
The center line of any bar shall not come closer than two diameters or less than 1⅛ in. to any concrete surface, and all steel shall be held in place to true alignment by means of wire staples driven into the form, pegs, or some other efficient device.

In accordance with these, the bars should have had a minimum covering of 1⅛ in.; as the work was carried out the balustrade bars in places had a covering of ⅛ in. The pockets in the arch ring are due either to an insufficient amount of mortar in filling the voids in the coarse aggregate, to leaky forms, or to the concrete not having been properly spaded and left around the reinforcement. It is clearly evident that the defects are due to careless workmanship, made possible by poor inspection.

The Three-Lead Piledriver shown in the accompanying halftone is used by a contractor in building pile-bent bridges in the Philippines. It has a braced cantilever underframe carrying the engine on the rear end, and the leads on the forward end. The three leads are side by side and are used in driving the three piles which form each timber bent. One hammer is used and is swung from lead to lead as the pile is to be driven. The photograph was published in the January 14th issue of the Quarterly Bulletin of the Bureau of Public Works of the Philippine Islands.



A New Steel Sheet-Piling Shape for 90° Corners of rectangular coffer-dams or retaining walls is now rolled by the Lackawanna Steel Co. (Lackawanna, N. Y.). These curved corner shapes shown in the left half of the cut in conjunction with the two types of Lackawanna piling, do away with the fabricated corners such as shown in the right half of the cut. These shapes are rolled with either the hook or the guard on the outside, as shown. They weigh less than fabricated corners and are applicable under normal conditions of loading. Where a variation from 90° is desired, a special shape will be rolled for a reasonable additional charge.



NEW AND OLD CORNERS, LACKAWANNA SHEET-PILING

Editorials

The Alaska Railway Engineers

The great adventure in government railways in this country is at last afoot. This week the President selected the three engineers who are to locate the thousand miles of railway across the Alaskan peninsula. The men named are not of nation-wide reputation in the engineering field but, jointly, they present a certain fitness for the work which they have in hand. One is of long experience as locating engineer on railways of the mountainous West, the second has spent years in the survey of the subarctic North and the third has served practically his entire engineering career as engineering and administrative head of the only government railway. Thus they bring a composite experience in railway location, acquaintance with local conditions, and familiarity with government administration, the three requirements for success in this particular venture. If they can fuse their individual attainments into a unified control, the success of the preliminaries to government railways in Alaska is hopeful. Meanwhile, many of their professional brethren will envy them their opportunities in this, the last great pioneer railway work on this continent.

Power from the Sun's Heat

A great deal has been published in scientific and technical journals within the past half-dozen years concerning the experiments on a large scale in developing power from the sun's heat, which have been carried on by Frank Shuman, of Tacony, Philadelphia. In our issue of May 13, 1909, we gave an extended account of Mr. Shuman's work up to that time and also of work carried out by other inventors.

For two or three years past, Mr. Shuman has been engaged in erecting a large sun-power plant near Cairo, Egypt. In this plant, he abandoned his scheme for heating water to a moderate temperature, which we described in 1909, and returned to the earlier scheme of concentrating the rays of the sun by reflecting curved mirrors upon boilers containing the water to be evaporated. Various accounts of this plant have appeared in popular scientific journals, but the first engineering analysis of it with the results of tests thereon was made public in a paper read on Apr. 6, in London, before the Society of Engineers by A. S. E. Ackermann.

Briefly summarized, the plant erected in Egypt covered seven-eighths of an acre of ground and the highest output of power obtained from it in the test was only 19.1 hp. While it is claimed that the low-pressure steam engine which utilized the steam did not work satisfactorily in the test, it was evident that even had the engine worked with as high a degree of efficiency as could possibly be expected, the power output would have been a mere trifle compared with the enormous cost and space occupied by the plant.

As has been made clear in previous descriptions of Mr. Shuman's work, he has carried on experiments on a very large scale and has utilized in his work the abilities of thoroughly capable engineers. The results are well worth placing on record for their scientific value, but as a commercial enterprise the production of power from sunshine appears to be about on a plane with the proverbial industry of extracting sunshine from cucumbers.

The Most Powerful Steam Locomotive in the World

Elaborate papers have been read before engineering societies recently in which the authors demonstrated, to their own satisfaction at least, that the introduction of electric traction was an economic necessity to the railways of the country because the steam locomotive had reached the limit of its hauling capacity.

It is interesting to recall these deliverances in view of the description published elsewhere in this issue of the monster locomotive just completed for the Erie R.R., by the Baldwin Locomotive Works, which has a maximum tractive capacity of 160,000 lb. It will not be denied, of course, that it would be quite possible to build an electric locomotive which would have a tractive capacity equaling or exceeding this amount, but the cost of such a machine would be so great as to require on most railways operating under present financial conditions a special bond issue for its purchase. Besides, it has yet to be demonstrated that there is any large demand for a locomotive, either steam or electric, of such abnormal capacity.

This new monster locomotive for the Erie has been built for special pusher service on heavy grades, but it is extremely doubtful whether any competent railway expert versed in operating economics would advise the use of any such enormous machine for road service. As has been before pointed out in these columns, the probabilities are that the economic weight of freight trains has been in many cases exceeded.

It is worth pointing out, also, that this new locomotive knocks on the head another stock argument of the advocates of railway electrification. The steam locomotive has been unmercifully attacked by the electrical engineer because it is under the necessity of hauling behind it, uphill and downhill, a tender carrying its supply of fuel and water. Electrical engineers have argued that this weight was so much deducted from the available hauling power of the machine since the weight of the tender was not available for traction. Now comes Mr. George R. Henderson, Consulting Engineer of the Baldwin Locomotive Works, and puts a set of driving wheels under the tender and in this way constructs a steam locomotive which has as large a percentage of its weight available for traction as the electric locomotive.

It would seem among the possibilities that this same idea might be applied to locomotives of ordinary size for road use on lines where steep grades demand heavy traction and it is desired to avoid the use of pusher engines.

We would not be understood by any means as opposing the use of the electric locomotive where economic and

other conditions make its use advisable. What we do urge is that in the discussion the relative economic advantages of electric and steam traction it is well to stick close to facts.

The American Water Works Association

A few years ago, the American Water Works Association was in an alarmingly rapid state of decline. To say the least, its finances were in woful shape and its membership, if not falling off materially, was certainly not increasing as it should. The programs at the annual conventions were full enough—often too full—but a considerable number of the papers were not of much value to the membership at large. The *Proceedings* were long delayed in publication.

This unhappy state of affairs was recognized by a number of members who have since devoted themselves unstintingly to the upbuilding of the Association. The result has been most gratifying. The finances of the association have been put on a sound basis. The membership has passed well beyond the thousand mark. The character of the annual programs has been improved and the *Proceedings* have been made better and have been published more promptly.

Two notable advances made by the Association within the past year have been the formation of local sections and the establishment of a quarterly *Journal*. The New York and New Jersey section was formed early in the present year and has since held a second meeting in New York City. The first number of the *Journal* appeared dated March, 1914, with nine papers, filling nearly two hundred pages, and with a good line of advertising.

These two new features of the Association will greatly extend its usefulness and should aid materially in the campaign for enlarging its membership. The local sections will serve many who cannot often attend the national annual conventions, and in addition will make possible in some localities a series of meetings between the annual meetings. The *Journal* will insure prompter publication of some of the papers, besides helping to increase the number and character of both papers and discussions. Then, too, a quarterly *Journal* will not stagger the members by its hugeness as does a bulky annual, which gives a whole year's doings in one big dose.

Although the Association has done well, passing beyond the thousand line in membership, it has not half, no, not a quarter the number of members that a national water-works organization should have. No one knows how many water-works plants there are in the United States today. It is safe to say that there are 5000. Some may think that it is too much to expect that every water-works plant should be represented in the Association, but even if that be granted there should certainly be an average of one member for each works, since many works are already represented by more than a single person, and there are several hundred works which should have from two to twenty or more of its officials and employees in the Association. It seems unnecessary to argue further that the membership of the Association should be rapidly increased until within a few years it will number 4000 to 5000.

With such a membership, much could be done that is now out of the question. For instance, a permanent headquarters, with a full-time Secretary-Editor and a good library would then be feasible, and the size and usefulness of the *Journal* could be increased.

The most rapid way to increase the membership of the American Water Works Association seems to be to get the water-works organizations now confined to one or a few states to become sections of the national organization. We have not the temerity to suggest that the time has yet arrived for the New England Water Works Association to merge with its sister, but the Central States, Tri-States (Carolinas and Georgia), Southwestern and various state organizations could advantageously do this at once.

Next to gathering in the sectional associations, and as a great aid to that end, the membership could most rapidly be increased by doing more than is now done by the Association for the superintendents and other officials connected with the smaller works. In the days when the New England Water Works Association was so far ahead of the American—or should we say when the American was so far behind the New England?—one of the chief arguments for trying to continue and to raise up the American Association was that it did so much more for the ordinary superintendent than did the New England Association. Although it might have been difficult to prove the contention, the claim carried conviction to many. The facts are, however, that neither association has done anything like what it might do and ought to do for not only the men connected with the smaller water-works but also for the rank and file of the officials and employees of the large works and for the many engineers engaged in designing and building small works and in making minor extensions to and filling the humbler positions on the large works.

Strangely enough, the *Proceedings* of the two leading water-works associations contain comparatively little to show that water-works have to be operated as well as designed and constructed. The association which is the first to see this neglect of a very important field and to act effectively in it will make great strides in membership.

There is one feature of the small and sectional water-works associations which simply must not be overlooked: their attention, in conventions, to some of the elementary phases of water-works. It is true that much of the discussion before these associations betrays ignorance, but it is the ignorance of the would-be learner, and, moreover, an ignorance which these seekers after knowledge would be loath to betray before a national water-works convention. It is on this account that the local organizations must be continued in their essential character, even though they do become sections of the national association. Uniting with the latter, however, will strengthen the local organizations in many ways, not the least of which will be the sharing of the broader experiences of the much larger membership of the national organization, both at the local meetings and through the *Journal*.

Finally, we congratulate the American Water Works Association for its recent progress and even more for its future prospects. At the same time, we caution the membership at large that the improvements of the last few years have been largely the work of a relatively small group of members who stepped into the breach at a critical moment in the history of the Association. If recent progress is to be continued and the bright prospects of the future realized, the work of the Association

hereafter must be shared in by a larger number of members than in the past. The *Journal* will open new opportunities for the rank and file of the membership to exchange experiences about the more ordinary everyday water-works affairs—which, after all, are the chief concern of the vast majority of the water-works fraternity.

Civil Service Laws in Practical Operation

One of the features of the movement for better municipal government, which has been in progress for some years, is the enactment of state laws or municipal ordinances placing city employees under civil-service rules. Engineers as a class will generally be found favoring good government and favoring also any means by which good government may be attained; but it may be safely laid down as a general proposition that the engineer who has been accustomed to carrying on work with the economy characteristic of a well conducted private enterprise is apt to protest inwardly, if not outwardly, if he takes up public work and finds himself subject to the iron-clad restrictions of civil-service laws in employing and discharging men.

Engineers who have experience in state and municipal service where civil-service laws prevail, however, recognize that these laws have their advantages as well as their disadvantages, not the least of the advantages being that the engineer in charge is to a large extent relieved from the constant political pressure to find places for certain men regardless of their competence for the work.

Whether the disadvantages or the advantages are the greater, however, makes little difference. The engineer recognizes that the civil-service laws are one of the conditions he must meet in carrying on his work, as much so as the presence of a difficult foundation or high prices for material. Occasionally, however, the engineer, as he wrestles with the task before him, cannot refrain from wishing that some of the men who framed the law were obliged to bear some of the burdens and the difficulties of carrying it into execution which fall upon the shoulders of the engineer.

We have several times discussed in these columns the absurdity too often found in civil-service laws of compelling candidates for high executive or technical positions to pass an examination, the difficulty being in the first place to find any examiners or examination which will fairly test the relative qualifications of competing candidates and in the second place to frame any sort of examinations, the results of which can be mathematically expressed so as to in any way indicate those personal qualifications on which the success of a man in executive duties chiefly depends.

Another error of civil-service laws at the opposite extreme is the requirement that unskilled laborers shall be selected by competitive examinations. An interesting example of how an ordinance of this sort works is reported at Cleveland. The new State Constitution of Ohio, which enables cities of the State to frame their own charters, has resulted in a new charter for the city of Cleveland. Those who framed this new charter provided a City Civil Service Commission, whose duty it is to see that all city employees, except those in the unclassified list, "are selected on the basis of merit and fitness." The unclassified service includes only elective officers and a very small number of appointed officers, such as the heads of the six city departments and their direct assistants, 21 in number. All the remaining city employees are divided into three classes: Competitive, noncompetitive and laborers, which are described as follows in the charter:

> (a) The competitive class shall include all positions and employments for which it is practicable to determine the merit and fitness of applicants by competitive examinations.
> (b) The non-competitive class shall consist of all positions requiring peculiar and exceptional qualifications of a scientific, managerial, professional, or educational character, as may be determined by the rules of the commission.
> (c) The labor class shall include ordinary unskilled labor.

While the Charter Commission provided that laborers should be selected for merit and fitness and their positions should be classified and standardized to a certain extent, they left to the Civil Service Commission the working out of detail problems in connection with the execution of the law. The new charter only went into operation on Jan. 1, but already some interesting experiences have occurred in connection with the employment of labor.

The extension of the west side intake tunnel for a better water-supply, 16,000 ft. into Lake Erie, at an estimated cost of a million dollars, is to be done by the city by direct labor. When the work was begun, the Water Commissioner made application to the Civil Service Commission for an eligible list from which laborers might be hired. Now, tunnel workers, like some other special labor, are an itinerant class, working in one place until the job is done, or until wanderlust impels them to leave. They didn't take kindly to the idea of civil service, nor would they attempt to find out what kind of an examination they might have to pass. The only examination they were used to, was the keen gaze of the boss to whom they apply for a job. They hold their job so long as they show ability and willingness to do the work. The result on the tunnel is that the Civil Service Commission has no eligible list so that the Water Commissioner is obliged to hire men when and where he can get them. The Civil Service Commission does not expect to put the tunnel workers in the classified service.

Excavation for the new filtration plant is also being done by the city by direct labor. Here, the same difficulty was met in getting steam-shovel men under civil service as in getting tunnel workers. The Commission has found itself obliged to class the workers on these large undertakings as "special, emergency, or temporary," although under the charter, temporary employment for periods exceeding 30 days is not permitted.

Work in the division of streets is nearly at a standstill during the winter months, but with the coming of spring, a large force, nearly a thousand men, must be recruited in a short time. Laborers applying for work are required to appear before the Civil Service Commission, where, if they seem sound in body, they are registered and then are sent out on the job. Registration consists of recording the applicant's name and address, together with a statement of previous employment. The street-repair department has been quoted in the daily press as complaining that one piece of work was unduly expensive, because labor sent by the Civil Service Commission, which the

repair department was obliged to accept, was inexperienced.

It would appear extremely doubtful whether it is wise to include under civil-service laws common labor taken on for temporary employment only, such as that which is required when a city undertakes to do by day labor, construction work on jobs which are ordinarily let to contractors. If the engineer placed in charge of such work is expected to obtain the same efficiency and economy in the work that would be obtained by a private contractor, he ought to be equally free to select his assistants and his labor. If he cannot be trusted to do this as well as a Civil Service Commission could do it for him, it is doubtful whether he ought to be employed as the engineer.

Taxing Motor Vehicles in Proportion to Their Horsepower

To an engineer, especially an engineer engaged in highway maintenance who is face to face with the problem of maintaining roads subject to present-day automobile traffic, it seems a fair and equitable proposition to base the fee for an automobile license upon either the horsepower of the machine or its weight. The horsepower, however, is preferable to the weight as a basis for the wear and tear upon a roadway depends very much more upon the power of a machine than upon its weight. It is the high-power racing cars tearing along at a 40- or 50-mile an hour pace which destroy the surface of a roadway and send the binding material flying into the ditches. This has been so amply demonstrated in the experience of road engineers that no argument is needed to prove it.

In Great Britain and in the State of Massachusetts, laws have been in force for years under which an automobile license fee is based upon the horsepower rating of the machine. In both Great Britain and Massachusetts, the revenue derived from these fees is devoted to road maintenance. We cite these only as typical cases. In numerous other countries and states, laws are in force basing the fee for a motor license upon the power of the machine. It is, therefore, a matter of surprise to learn that the Supreme Court of Michigan has just declared unconstitutional a law enacted in that state last year fixing the registration fee for automobiles at the rate of 50c. per horsepower. The court said in its decision:

> The clear purpose of the legislature in exacting so large an amount from the owners of motor cars was to produce a fund for highway purposes under the guise of regulation which makes it a tax measure which is clearly not covered by the title of the act. There can be no more labor or expense in registering a vehicle of high horsepower than in registering one of low power, and the only reasonable purpose in the graduated fee is the increased revenue.

It seems probable from the above quotation that the court decision is based on the technical ground that the purpose of the law was not properly stated in its title. It is, however, a notable coincidence that Michigan, which leads all other states in motor-vehicle manufacture, should be the State where the courts find a way to nullify a law which the makers of motor vehicles doubtless deem to be contrary to their interest.

Another opinion bearing the weight of authority, to a certain extent at least, is found in the report of the New York State Commission on Motor Vehicle Legislation recently submitted to the New York legislature. We quote from the report as follows:

> In our opinion the exaction of a tax in the form of a registration or license fee which produces more revenue to the state than is reasonably necessary to cover such expense is an unjust and improper exaction upon one type of vehicle. It may be urged that motor vehicles should pay license fees graded in proportion to their horsepower, on the presumption that motor vehicles damage the highways. In answer we would state that highways of the state are for the use of all its citizens—their improvement is for the benefit of all its citizens. Before the motor vehicle the roads were bad and their use was comparatively limited. The improvement of the highways was as desirable then from the standpoint of the pedestrian and the users of horse-drawn vehicles as it is today. The motor vehicles merely accentuated in the eyes of the public the need of better construction and maintenance of roads, and made apparent the need for improved highways. Your Commission fails to see, therefore, why motor vehicles should pay any exaction whatsoever which other users of the highway do not pay. We believe that motor vehicles should be subject to taxation upon the same basis as other personal property and that in this way the owners of motor vehicles will bear a just burden of taxation in proportion to the value of their cars, irrespective of horsepower.

The position of the Commission evidently is that the taxpayers of the state are bound to maintain the roads in condition for the use of any and all vehicles, and that it is inequitable to tax the users of vehicles so that they will have a larger part of the burden laid upon the taxpayers by reason of the damage which their vehicles do to the roads than is borne by owners of other property.

Such an opinion ignores the many cases where special taxes have been laid upon all classes of vehicles or upon special classes of vehicles which were believed to be especially damaging to roads and street pavements. What the commission alludes to as the presumption that motor vehicles damage the highways is to road engineers not a presumption at all but an established fact. Laws and ordinances requiring vehicles which do special injury to roads to pay special tax on that account are extremely common. We may instance the wide-tire laws passed in many States or the requirement that a person drawing an especially heavy load over a road is obliged to make good the damage caused thereby.

Possibly if a road maintenance tax were to be adjusted with theoretically exact equity, the owner of every vehicle traveling over the road, including wheelbarrows, baby carriages and bicycles, as well as wagons and automobiles, should be required to pay a fee proportionate to the damage which his vehicle causes. But all systems of taxation are only rough approximations to an equitable adjustment. Sufficient warrant for the assessment of a tax on automobiles, graduated in proportion to their power, when no taxes are assessed on other vehicles, is found in the amount of injury done to road surfaces by motor vehicles in comparison with other vehicles.

The attempt of motor-vehicle manufacturers and owners to defeat laws intended to place upon motor-vehicle users a part of the burden of road maintenance which their use of the roads causes is in the highest degree unwise. If those who benefit by the use of motor vehicles are not willing to pay for at least a part of the damage which they cause, the taxpayers as a whole are certain to protest at the burden. Indeed at the present day one of the largest problems of the engineers responsible for road maintenance is to obtain funds sufficient to do the work which is absolutely necessary to prevent expensive road surfaces from being entirely destroyed.

Letters to the Editor

Ethics and Compensation of Engineers from the Standpoint of a Lawyer

Sir—The editorial in your issue of Jan. 22 correctly points out that the salary figures compiled by American Society of Civil Engineers do not represent a fair average. The correspondent "Citizen Engineer," in the issue of Feb. 5, in commenting upon the editorial, recommends a higher standard of ethics as a means of correcting an undesirable condition.

The term "ethics," however, is one of the most abused and overworked terms in the language. An active writer on engineering ethics, prominent in the American Society of Civil Engineers, who would unquestionably consider it unethical for an engineer to guarantee or assume the financial responsibility for the commercial success of a new design, in practice, had no scruples about reporting under his own signature, on the same day, that the same railroad project would cost $17,000 per mile in his report to the promoting company, and $25,000 per mile in his report to the provincial ministry, for the purpose of securing a subsidy for the promoting company of $20,000 per mile.

A member of the Joint Committee on Concrete and Reinforced Concrete, testifying in a patent suit for an employer desiring to demonstrate the action of reinforcement in the top of a slab, had no difficulty in conveying to the Court the information that this committee believed in the tensile strength of concrete in beams and slabs, and explained glibly that it only disregarded this valuable element of tensile strength in these rules as a mere matter of convenience in figuring.

It would seem that the public might certainly appreciate and more richly reward a more universal exhibition of common ordinary old fashioned honesty and business progressiveness and fairness on the part of the engineering profession.

It is evidently not good form or ethically conservative to consider seriously any new idea until it has reached the legal age of maturity, 21 years. This statement seems justified by the careful consideration of nearly all engineering-committee reports and especially by engineering testimony concerning all concrete failures. Such testimony always shows that as certain old conservative rules have been followed by the designer, the design is ethically correct, and the blame must be attached to some inoffensive little chip or microscopic grains of sawdust located in some part of the work.

Nothing could possibly be due to the engineer, for has he not indeed followed 21-year old rules? This being so, it can be only predestination or fate at the bottom of the unfortunate catastrophe; and no question of engineering judgment could possibly be involved in the selection or arrangement of materials by the engineer.

Fairness calls for the explanation that cases of such dishonesty as cited are extremely rare among the best engineers. It is an unfortunate condition, however, that the great majority of these really able and honest men are so absorbed in considering only technical matters that they do not cultivate business acquaintance; do not combine technical industry with business activity, and hence are for the most part under the direction of the jolly promoter, who has neither technical ability nor inclination to consider technical questions, except in that superficial manner requisite to put up a plausible line of talk in selling engineering services. Such a promoter generally employs able engineers on a minimum salary to carry out such antiquated schemes as he has thoughtlessly talked up to his client. This is an ethically commercialized engineering condition.

The foregoing cynical effusion would only be complete if properly classified and duly labeled as the warped judgment of that most undesirable kind of a citizen—that disturber of conservative 21-year-old ideas—known by the offensive name of

A PATENTEE*.

Chicago, Ill.,
March 2, 1914

More Concerning Contractors' Surety Bonds

Sir—If an insurance man with no training as an engineer attempted to lecture engineers as to their shortcomings, he might create a great impression upon his fellow underwriters but he would probably be received with derision by engineers. So when an engineer like Mr. Lincoln Bush attempts to lecture surety underwriters for their alleged shortcomings, his letter published in your issue of Apr. 9, p. 800, is more deserving of a tolerant smile than of serious refutation. Nevertheless, you will perhaps permit a surety underwriter to touch on a few of his points.

It is quite true that "there is no regular uniformity in the amount of bonds specified by engineers even though the hazard and character of the work is similar." Yet as nearly as we can find a definite complaint in Mr. Bush's somewhat rambling disquisition, it is that surety companies ought to base their rates on the amount of the bond rather than on the amount of the contract. Mr. Bush says that the surety companies "have united in requiring the contractor to take out a bond on the total amount of the contract." This statement is simply and wholly false. Surety companies have not made any such requirement either singly or unitedly. They have, in fact, nothing to do with fixing the amount of bond. In many states the amount of bond on public works is fixed by statute. In other cases, it is fixed by the regulation of governing boards, administrative officers, boards of education, water-works, park, etc., and divers and sundry inferior commissioners or officials of every sort. There

*By addressing F. H. Drury, 1610 Fort Dearborn Building, Chicago, Ill., court records involving the railroad case and the concrete testimony will be furnished to any interested parties.

is no uniformity of plan or method and there is the greatest diversity of result.

Under these circumstances, surety companies have felt that the only basis on which contract underwriting experience could possibly be standardized is to fix their contract bond premium rates on the amount of the contract rather than on the amount of the bond. Mr. Bush complains of this purely on the assumption that it is always excessive. He thinks his clients would save money where small bonds are required. But there are States and cities where bond is required in double the amount of the contract price and other States and cities where the bond is only 25% of the contract price. If the rate were made on the amount of the bond instead of on the amount of the contract, the premium charge on the same contract would be in one case eight times as high as in the other. Complaints of the present basis of fixing premiums are trifling compared to the outcry that would be caused by such a change as Mr. Bush advocates.

Mr. Bush speaks of the "good judgment of the engineer, who should be fully qualified to appraise the hazards connected with the work." He should be, perhaps, but sometimes he is not. See United States vs. Stone, Sand & Gravel Co., 177 Fed. Rep. 321, where the U. S. Government lost $225,000 on a contract for which it had only a $75,000 bond.

Speaking generally, it may be said that the hazards estimated by an engineer are the engineering hazards. The hazards carried by surety companies' bonds are a great deal more than this. Contract bonds to the Federal Government and in many States make the surety liable for the payment of labor and material employed on the contract. This liability extends to the payment of indebtedness of subcontractors. Hence the surety on the bond of a general contractor may be liable for the debts of insolvent subcontractors whom the surety never bonded and never saw. The surety may become liable owing to the dishonesty, the speculation, the misfortunes, the incompetency or the death of a contractor. It may be liable for the inadequacy of the contract price, for the insolvency of subcontractors, for floods, fires, frosts, strikes, accidents, catastrophes and for the mistakes of engineers.

The surety's bond is much more than a mere undertaking that the project will be carried out. It guarantees the debts of the contractor and it is used by him as a basis for credit. It protects the private owner against liens. It is a financial guarantee. Surety companies as a whole have never made money on this part of their business. There is little prospect that any money will be made upon it in the future. It constantly attracts new capital into the field of surety insurance by just such specious arguments as Mr. Bush's letter and your editorial. The unvarying result in the past and one that may be expected equally in the future is that those who venture into the field of contract bonding will lose their money and become wiser and sadder men.

R. H. Towner.

62 William St., New York, Apr. 21, 1914.

Sir—I have read with considerable interest the letter of Lincoln Bush, concerning Contractors' Bonding Companies, and your comments in connection therewith, appearing in Engineering News, of Apr. 9, 1914. The protest of Mr. Bush is timely and pertinent, as it is generally conceded that the present procedure is far from satisfactory. The scheme which contractors are operating under to guarantee the faithful performance of a contract and the payment of bills for labor and material is a costly one and is reflected in the total outlay of the owner.

It is a matter of common knowledge that the premium of one-half of one per cent. of the contract price is the principal interest the Bond Company has in furnishing a bond to a contractor. If the contract price is such as to raise doubt in the mind of the Bond Company that the work cannot be executed for the sum proposed, the Bond Company requires the contractor to furnish a guarantor or put up security sufficient in their opinion to protect them from possible loss. In other words, if the Bond Company were called upon to perform the service for which they had been paid, they are at no risk as they have ample protection. It would seem far better if the contractor could furnish directly to the owner the same security which he would be required to furnish the Bond Company. Such security could be placed in escrow and the contractor would always be reaping the benefits of its earnings. This would also save the owner $500 per annum on every $100,000 of contract price.

Experience has taught us that when a Bond Company is called upon to complete an abandoned contract and to pay claims, the normal procedure has been for the Bond Company to make a settlement at a discount even though the bond is conditioned upon the payment in full of all claims of persons furnishing labor upon or furnishing materials used in the work. To obviate the possibility of a Bond Company settlement, and to insure legitimate claims being paid in full, the common practice is to insert a clause in the contractor's contract, stating that the sureties on the contractor's bond will not be permitted to complete the work without the consent of the owner. With such a stipulation, the owner is in a position to demand of the Bond Company the terms under which it intends to pay claims, and if it proposes to make other than full payments, the owner may then pay claims, in which event the sureties would be liable to the owner for the damages sustained by him in making just and equitable settlements.

In most cases where a bond is required, the Bond Company endeavors to have its form of bond used in preferance to a form proposed by the owner. The reason for this is obvious. The Bond Company is anxious to provide an instrument drawn in a manner to remove the danger of its ever suffering loss in the event of failure on the part of contractor to perform his obligations. The net result is that the Surety Company has been paid for a service which it never performs.

A good bond should by its terms be such, that any change in the condition surrounding the work, any increase or diminution in total cost, any changes or alterations of the work or modification of the contract between the owner and the contractor shall not act to release the sureties upon the bond. Further, a bond should be such, that if the contract is materially increased in amount, additional security may be obtained under it. It is believed that with these stipulations and with that above mentioned relative to not allowing a Bond Company to complete the work without permission of the owner, the owner may be reasonably secure. Considering the legislative trend toward making the owner ultimately respon-

ible for claims, the contractor's bond cannot be too tightly drawn, especially since the owner is called upon to pay a good price for the service intended to be rendered by the Bond Company. The engineer should always include in his specification a form of contract and bond which will be required of the successful contractor in order that there may be no misunderstanding relative to this feature.

After a careful analysis of all the considerations, it would seem far better for the owner, the contractor and those supplying material or performing labor, if the specification would permit a contractor to deposit in escrow, cash or securities, to be used to settle claims in the event of failure on the part of the contractor to satisfy them.

The amount to be deposited would depend entirely upon the terms of payment proposed. Take for instance, a contract of one million dollars. Assume, for the sake of argument, that $500,000 will be paid to labor and that $500,000 will go into materials. Assume further that payments will be made on the basis of 75%, as the work proceeds with a 25% retention. It is known that a contractor cannot long fail to meet his payrolls because the mechanics and laborers will not work if their wages are not forthcoming, obviating thereby great accumulation of debt in this direction. With the present leaning toward State Industrial Commissions, there is offered the owner further assurance that labor claims will be met. Therefore, in the event that the contractor's price is low, or the work has been mishandled, resulting in abandonment or unpaid claims, the only bills to be paid are those for materials furnished.

If the work has advanced to completion, and the material claims remain unpaid, the 25% retention and the escrow securities would probably afford sufficient funds for meeting all legitimate payments. In this instance, there would be at hand $250,000 retained payments and the securities. It would be proper in the case in point to have required the contractor to put up securities to the value of $250,000, which is just one-half of the amount of the bond normally required in such an instance.

The engineer's and owner's control over a piece of work under such a procedure is far more perfect because a contractor would be loath to do anything improper in connection with a contract when it is considered that his rights in the matter of the escrow funds would possibly be prejudiced. The writer has concluded, after extended experience in dealing with contractors and Bond Companies, that one hundred dollars cash or security deposit is worth a thousand dollars of surety bond.

In the event of dispute in the progress of the work or in the final adjustment of the contract, it remains only for the owner and engineer to stand firm. It will then be incumbent upon the contractor to take legal steps if he is being, in his opinion, unjustly treated. The burden of proof would rest with the contractor instead of the owner, since it is the contractor's funds which are at stake. In case of the surety bond, however, the conditions are exactly opposite, inasmuch as it remains for the owner or the creditors to start suit to obtain justice from the Bond Company.

By such a method, all doubtful bidders would be eliminated first hand and the result would be that only bidders of sound financial standing would be in a position to submit bids. Clauses in the specifications could be drawn to provide that the owner would require escrow securities in amount not exceeding a stated sum, which sum would be largely determined by the character of the work and hazard connected with it. The exact amount of security would then be determined at the time the contract was let and would be such an amount, as, in the opinion of the engineer, was necessary. The bidder's price and standing and the engineer's estimate would constitute the factors to determine the amount of the cash or security bond. If, for instance, the bidder's price was considerably below the engineer's estimate, the amount of security required would approach the sum named in the specification, while to the contrary, if the contractor's bid was such a one as to inspire the engineer in charge with confidence, the amount of security required would possibly be less.

There orght to be a change in the present procedure for another reason and that is the difficulty experienced by an owner in making collection from the Bond Company after he has paid the just claims and that experienced by creditors in collecting from a Bond Company in event that the Bond Company completes a piece of abandoned work.

It is the exception when a Bond Company comes forward in good faith to make the proper settlement without litigation. The usual experience is a long-drawn-out fight with many legal entanglements. The large Bond Companies maintain a skilled corps of lawyers, while the smaller ones engage expert legal talent to conduct technical defenses to avoid the payment of just and proper claims. There is no question whatever that in general the bond furnished by a Surety Company fails absolutely to serve the purpose for which it is intended. The subject is one of extreme importance to all those interested, and it is hoped that the American Institute of Consulting Engineers will evolve a method to protect the owner and others which has more soundness and justness than the present one.

A. H. MARKWART.

NOTES AND QUERIES

The New Orleans Bridge Project—The account of the revival of the project for a bridge over the Mississippi at New Orleans, in our issue of Apr. 2, 1914, p. 740, included a slight error. The following from E. L. Corthell corrects the error:

"You state that the plans on which the propositions were made were from designs of the Phœnix Bridge Co. This is not correct. They were from detail designs and quantities worked out by my then assistant, Mr. E. H. Connor, now President, Missouri Valley Bridge & Iron Co., Leavenworth, Ky.

"The Phœnix Bridge Co. did later make a 'modified cantilever design,' as well as a draw design, but they were not used in the competition in which entered Bonzano & Clarke, the Phœnix Bridge Co., and for the foundation, Anderson & Barr and Sooysmith & Co."

J. B. K. writes: "I beg to inquire of your readers when driven wells were first used in our country for lowering the ground-water level in places where excavations for sewers or buildings were contemplated. I have a distinct recollection of reading many years ago about the application of this process for facilitating the excavation of a sewer trench, but am unable to state the publication."

In the editorial comment in our issue of Apr. 30, on the 36-in. submarine pipe line across the Narrows for the Catskill Water Supply, it was stated that the contract cost was in the neighborhood of $250 per lin.ft. This figure should have been $100 per ft.

In the article "Decay of Wood Posts Encased in Concrete," "Engineering News," Apr. 23, 1914, the third last paragraph on p. 907 should read "The unit pressure is 316 and 373 lb. per sq.in." not "per sq.ft.," as printed.

Water-Filtration and Liquid-Chlorine Plant, Bound Brook, N. J.

By Clyde Potts*

SYNOPSIS—*A 2,000,000-gal. mechanical water-filtration plant of the pressure type, with liquid-chlorine disinfection as a finishing process. Liquid chlorine in place of bleaching powder is comparatively new and the dosing and regulating apparatus here described is particularly interesting.*

The borough of Bound Brook and South Bound Brook and a portion of Piscataway Township, N. J., are supplied with water by the Bound Brook Water Co. The consumption in these municipalities slightly exceeds 1,000,000 gal. per day. The water is gathered on a drainage area of 18 sq.mi., lying behind the Watchung Mountains. The water is collected in two storage reservoirs in the vicinity of Chimney Rock. The larger of these reservoirs has a capacity of approximately 5,700,000 gal. and the smaller a capacity of 1,600,000 gal. The elevation of the spillway in each case is 133.81 ft. above mean sea level. The average elevation of the boroughs supplied with water is something less than 50 ft., the business portion of Bound Brook being less than 35 ft.

The gathering ground has upon it some scattered farm houses but it is little traveled and contains no settlements. There are no cases of direct pollution, and the company has had little or no difficulty in keeping the drainage area in a sanitary condition. The farms are fairly large, and the company owns considerable of the land adjoining the reservoirs and brooks.

In 1912, it was decided to install some method of treating the water which had for 30 years or more been supplied to the communities. It was thought advisable to treat the water more for the purpose of removing the suspended matters following rainfalls, than for sanitary purposes. On most days of the year the water was clear, and while B. Coli were usually present, they were not present in large numbers, nor were they present in minute quantities of the water. For two or three days following a rain storm, and depending on its violence,

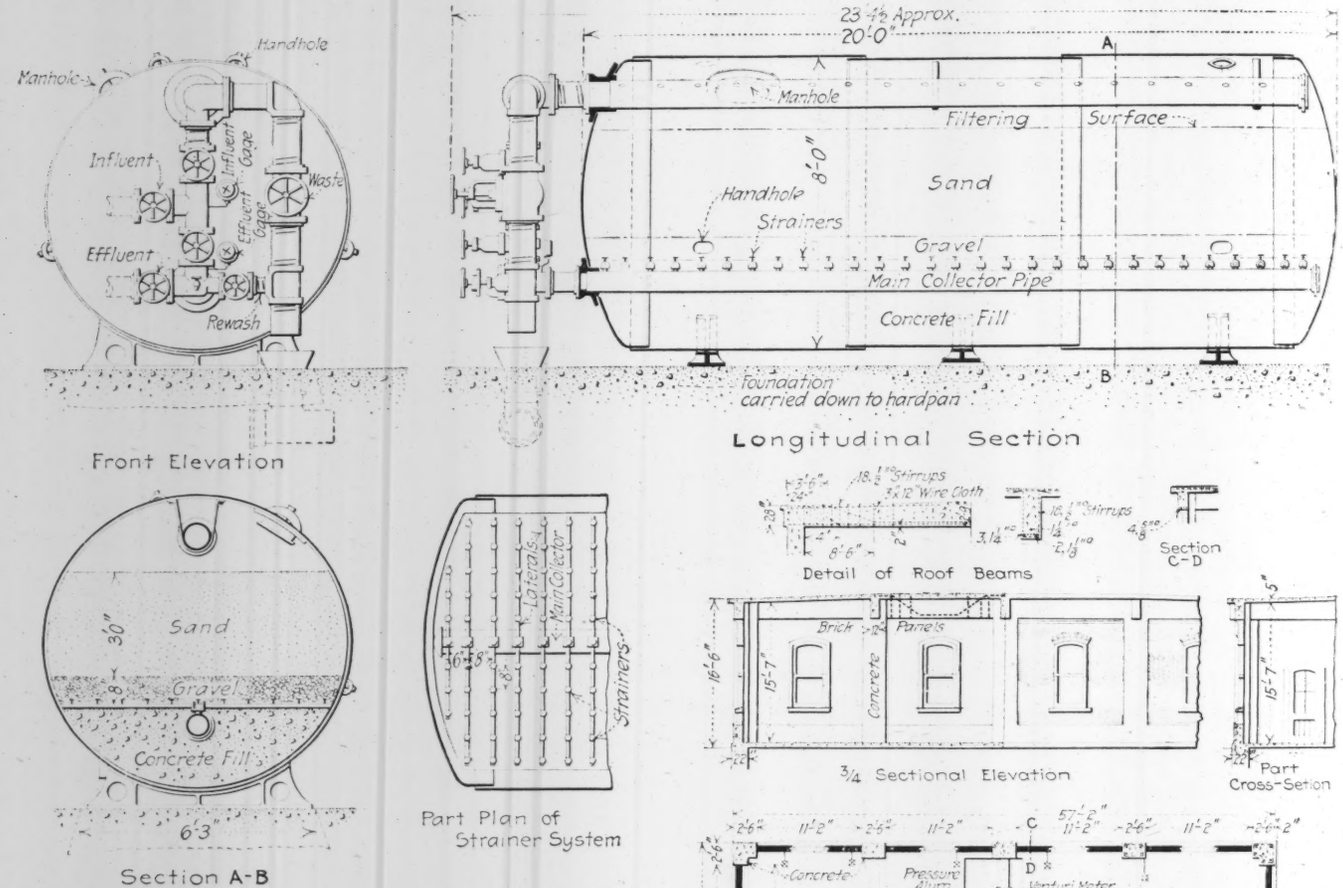


Fig. 1. Details of Mechanical Filter and Filter House, Bound Brook Water Co.

*Civil and Sanitary Engineer, 30 Church St., New York City.

water carried soil washings to such a degree that the reservoirs did not properly remove them by sedimentation. Considerable study was given as to what type of treatment would give satisfactory results and at the same time be economical in operation. It was not found possible to install either slow sand filters or mechanical filters without installing a pumping station to lift the

FIG. 2. MECHANICAL FILTERS, BOUND BROOK, N. J.
(The filters were set up on their foundations before the building was erected.)

water to the filters. These pumps were necessary as sufficient head could not be sacrificed to operate the mechanical filters. This would be especially true at times when the water in the reservoirs was drawn down below the spillway, as happens in the summer. The filters would need to be built even with or below low water in the reservoir.

Pressure filters were recommended and a contract was let for the installation of four 500,000-gal. Roberts pressure filters, giving a total capacity of 2,000,000 gal. per day, or an amount equal to twice the average rate of consumption. (See Fig. 1 for details of filters and filter house and Fig. 2 for view of filter tanks.)

Coagulation is obtained by the use of crystal lump alum. The coagulant is applied to the raw water automatically by bypassing a small amount of the influent through a pressure tank containing the crystal-lump alum. The water is bypassed into the tank with the use of pitot tubes, the upstream one being set against the current, and the downstream one with the current. A valve on the bypassing tank permits the throttling down of the coagulant. A pet-cock is also provided so that samples of the solution can be taken and its degree of saturation determined. No soda ash is used in the treatment of the water, as the alkalinity of the water was seldom found to be lower than 35 to 40.

After filtration, it was thought advisable to treat the water with a germicide in order to provide additional safety at all times. This disinfection is accomplished by the use of liquid chlorine. The chlorine gas is supplied directly into the main supply pipe leading to the borough, at a point just below the discharge from the last of the battery of filters. The apparatus employed to apply the liquid chlorine to the water is the Wallace & Tiernan apparatus, and is described by Mr. Tiernan at the close of this article.

The plant was put in use on Oct. 18, 1913, but was not finally accepted until Jan. 29, 1914, the operation of the plant being guaranteed for a definite period by the contractors. Pitometer measurements indicate that the plant is treating 1,000,000 gal. of water per day.

The disinfecting apparatus is set to use 1 lb. of liquid chlorine per day. This is equivalent to 0.12 part per million. The liquid chlorine is purchased in tanks holding 100 lb. each, at a cost of $10 per tank, or 1c. per lb. On a basis of 1 lb. per million gallons of water used, the cost of disinfection is 10c. per day.

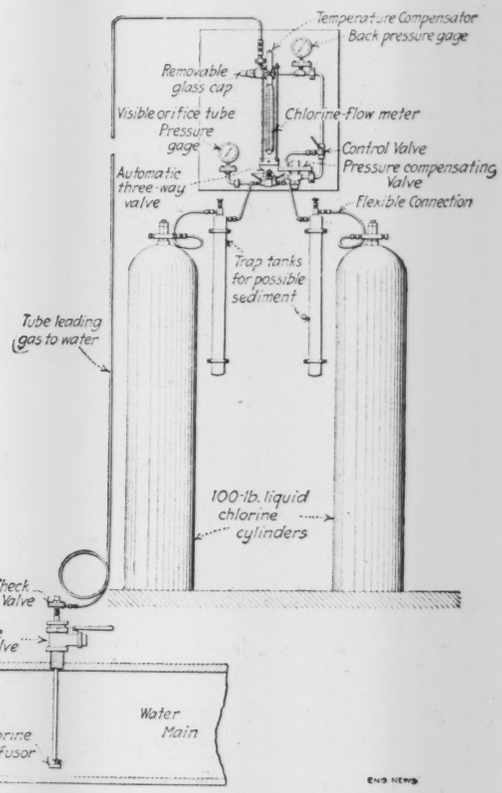


FIG. 3. LIQUID-CHLORINE CYLINDERS AND REGULATING APPARATUS FOR WATER TREATMENT, BOUND BROOK, N. J.

(Two cylinders of chlorine are attached to the flexible connection. The three-way valve is set to either side, and the valves on the cylinders of chlorine opened. Then the control valve is opened, till the flow meter shows that the desired amount of chlorine is being used. The pressure in the cylinder from which chlorine is being released will remain practically constant until the last drop of chlorine passes from the liquid to the gaseous state. Then when the pressure shown on the pressure gage falls to a certain set point, the three-way valve automatically throws over, cutting out the empty cylinder and at the same time cutting in the full cylinder of chlorine. This insures continuous operation of the apparatus. When the attendant comes around, say next day, and sees the three-way valve thrown over, he attaches a new cylinder in the place of the exhausted one. This new one will be automatically cut in when the second cylinder is used up. The chlorine-flow meter is of the manometer type. One side is connected ahead, and the other side connected after the orifice tube. The drop in pressure across this orifice is shown on the manometer scale, which is calibrated empirically in pounds of chlorine per 24 hours. The manometer-type gage is used in preference to the ordinary pressure gage, because it has no moving mechanical parts, and has greater sensibility over the entire range of chlorine flows. The orifice is made visible so that there need be no doubt as to its being clean at all times. Being made of glass, it cannot corrode. Should it be necessary to increase or decrease the capacity of the apparatus, without altering the sensibility, the glass cap is screwed off, and a larger or smaller orifice inserted, as need be.)

In the operation of the plant at Bound Brook, the liquid-chlorine tank is kept on an ordinary platform scale, and the loss of chlorine from day to day is noted by the reduction in weight of the tank. In order to check the apparatus a run of 31 days was observed, during which time 32.5 lb. of liquid chlorine were used. On

the second run, 16 lb. were used in 14 days. During the third check run 7.5 were used in 7 days.

The amount of alum used since the plant was put in operation has averaged 38 lb. per day.

The filters are washed about every other day. The connections are so arranged that one of the four filters may be washed with the filtered water from the other three, although on one or two special occasions when the raw water has been especially turbid and silt has caked on the surface of the filter, it has been necessary to backwash with raw water. After washing, the filtered water is allowed to run to waste for from fifteen to twenty minutes. Usually after washing, a slight excess of alum is used in order to form a covering on the sand more quickly.

The following analysis made on Mar. 14, 1914, is a typical analysis since the plant has been in operation:

	Raw, Filter House			Treated, Woodhouse's Restaurant		
	1 day	2 days	3 days	1 day	2 days	3 days
Positive	0	1	2	0	0	0
Negative	9	3	2	10	10	10
Doubtful	1	6	6	0	0	0
Acid	0	1	..	0	0	..
Other	18	21	..	0	43	..
37 degrees	79	254	..	0	58	..
	2 days	4 days	6 days	2 days	4 days	6 days
20 degrees	2280	Spreader	..	23	660	800

Chemicals used, alum and chlorine; alkalinity, 24; turbidity, 6.

Raw water taken from the tap on the 16-in. inlet pipe in the filter plant; treated water, taken after the application of the chlorine, is from a tap downtown.

In the test for B. Coli, lactose peptone bile is used. Ten tubes of the bile are inoculated with 1 c.c. each of the sample, and incubated at 37° C. for three days, and the amount of gas noted each day and recorded. Tubes containing over 25% of gas are recorded as positive, less than 25% as doubtful, and no gas as negative.

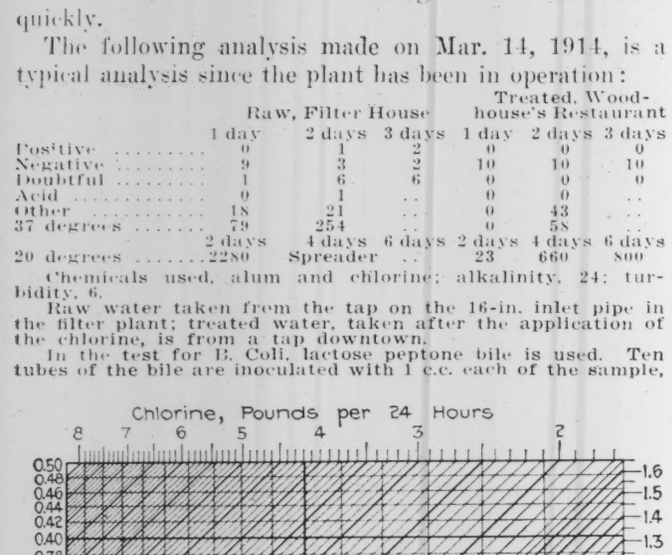


FIG. 4. LIQUID-CHLORINE DOSING CHART

The cost of the filters installed was $10,600 and of the building, connections and appurtenances was $5700, making a total of $16,300. The contractors for the filters were Louis Wheelwright & Brother. The building was erected by the company, under the supervision of Mr. Runyon Field. Walter C. Bowen was resident engineer for the writer.

The chlorinating apparatus in the plant is described in the following article by Mr. Tiernan.

Description of Liquid-Chlorine Regulating Apparatus, Bound Brook Water-Works

By M. F. TIERNAN*

The apparatus is of the manually operated type (see Fig. 3 and its descriptive note). It treats 1,000,000 gal. of water a day and has a maximum capacity of 8,000,000 gal. with the one orifice.

The arrangement of the chlorine-measuring orifice in conjunction with the temperature compensator renders the method of chlorine measurement simple and accurate.

The way of introducing the chlorine into the water deserves mentioning. The chlorine diffusor is made of carborundum sponge of very fine porosity. The natural pressure of chlorine in the cylinders forces the chlorine gas through the diffusor in the most minute bubbles. These, because of their fineness and area of distribution, and the fact that they are introduced into the water under pressure, go immediately into solution, according to the well known chemical law of the solubility of gases under pressure.

Without going into the chemistry of chlorine and its use in water disinfection, it is clearly evident that the greatest efficiency in its use will be obtained by introducing the chlorine in its most potent state directly into the water being treated. Chlorine gas in the presence of moisture is extremely corrosive, and will attack practically every known metal, even vulcanite, or hard rubber, being disintegrated. In the dry state, it is not nearly so active, and there are several metals that stand up very well: steel, platinum, nickel and copper. By the above-described method of disinfecting water by chlorine, every part of the central apparatus is kept perfectly dry, and free from corrosion. There is no danger from freezing, and the chlorine gas is introduced into the water in its most potent state. This means efficiency and economy of operation.

The accompanying chart (Fig. 4) of operation shows the method of control that enables the attendant to set the chlorine-flow meter so as to get the required amount of chlorine for any particular amount of water. For example: It is desired to add 0.12 parts chlorine per million parts water, when the flow of water is 1,000,000 gal. a day: From the intersection of the vertical line from the figure "1," at the bottom of the chart, with the horizontal line from the figure "0.12" at the left side of the chart; follow the oblique line to the right-hand side of the chart. The figure at this point "1," is the number of pounds chlorine necessary to give 0.12 parts chlorine per million parts water on a flow of 1,000,000 gal. a day. The calibrations on the right and upper sides of the chart are the same as are those on the chlorine-flow meter of the apparatus. This chart saves all computations by the attendant for varying flows of water or chlorine.

Water-works Supplying Cities in India provide a very small per capita allowance for the population according to American or even European ideas. "The Engineer," describing a new water-works system recently completed for the city of Gaya says: "The quantity of water to be provided is 12½ gal. per head for 100,000 persons. This is a generous supply for an Indian provincial town. No town in Bengal, except Calcutta and Darjeeling has so large a per capita allowance. The majority of Indian water-works supply from six to ten gallons per head of the population served and some cities only give between two to four gal."

*Of Wallace & Tiernan, 136 Liberty St., New York City.

Electric Water-Works Pumps Replacing an Old Steam Installation at Baldwinsville, N. Y.

The old steam pumping equipment of the town of Baldwinsville, N. Y., was replaced during the past year by electric-driven centrifugal units, under conditions which make the work of interest to all having supervision of small or old water-works pumping plants.

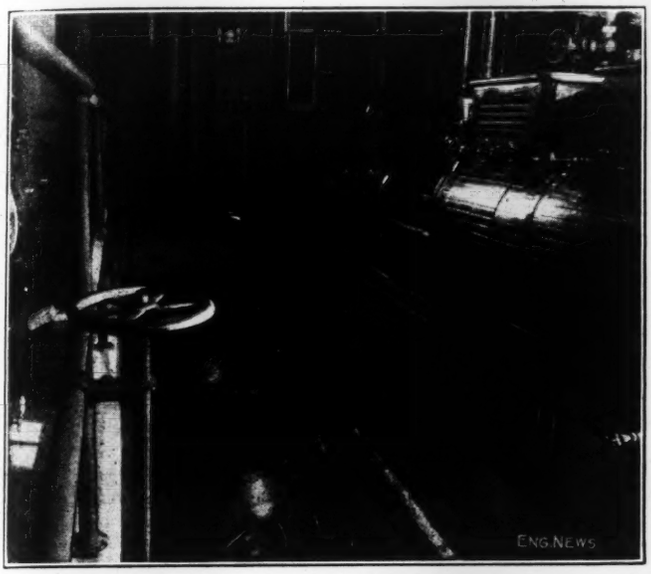
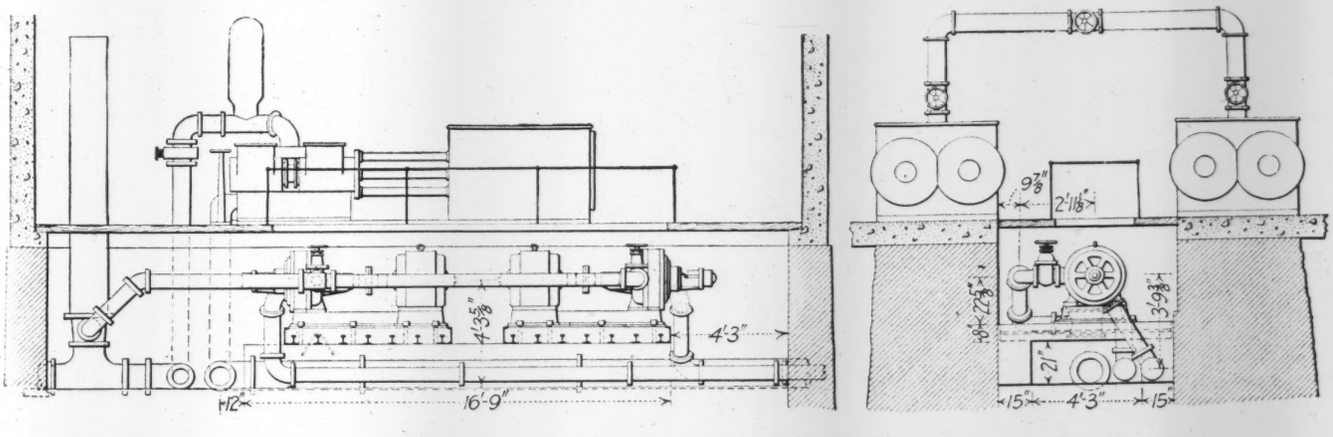


FIG. 1. INTERIOR OF REMODELED BALDWINSVILLE PUMPING STATION

In this plant, there were two compound double-acting duplex steam pumps (12- and 22-in. steam cylinders, 10-in. water piston, 18-in. stroke). These machines pumped through 12-in. street mains to a standpipe about 1½ miles away. The standpipe was 50 ft. high and 25 ft. in diameter, serving to equalize short peak drafts and to carry the night supply at times. The boilers of this plant, which was some 20 years old, had been showing signs of decrepitude and opportunity was seen by the superintendent of the local electric plant (Seneca River Power Co.), Geo. W. Pulver, for securing a favorable pumping load. After a couple years of educational work, the town accepted a proposal of the power company to install two motor-driven centrifugals and to receive $200 per month for five years—at the end of which time the plant would become the property of the town. In making this proposal, the superintendent of the local company had taken as a basis the expenditures for the plant as shown in the town reports for several years (averaging from $2300 to $2500 per year). The energy charge was taken at $130 per month, and the $70 per month additional served to pay the carrying charges of the installation and barely return the investment (approximately $3500) at the end of the contract. The company hopes, of course, to secure a contract for the supply of current after the plant becomes the property of the town.

The new equipment, shown in the accompanying figures, comprises two two-stage 6-in. (discharge opening) centrifugal pumps, bronze fitted, each direct connected to a 40-hp., 25-cycle, 2000-volt induction motor. The pumps run at 1450 r.p.m. with a suction lift of 15 ft. and deliver 400 gal. per min. at a discharge pressure of about 86 lb. normal. Independent suction lines were run to each pump to prevent interference, but each delivers to a common discharge. The old machinery was left in place (and is kept in repair for emergency service). A hole was cut in the engine-room floor to form a pump pit. A reinforced-concrete platform was built above the basement floor to support the new pumps just above the pipes. A three-phase three-wire line runs from the pumping station to the power plant and the pump is started and stopped from there, no attendant being required in the pumping station. A change-over switch in the pumping station enables the load to be put on either unit. The machinery is inspected and oiled once or twice a day, however, by power-company men. The pumps run some 12 to 15 hours per day at present and mostly in off-peak hours of the power plant. It was intended that they should operate entirely in nonpeak hours but adverse conditions have prevailed. For instance, 1913 was a very dry season and the water customers (not metered) drew much more than usual; then also the past winter was very cold and the people let their water outlets run all night to prevent freezing. The present ordinary daily energy consumption is 600 kw.-hr., but this has occasionally run up to a maximum of 900 kw.-hr.



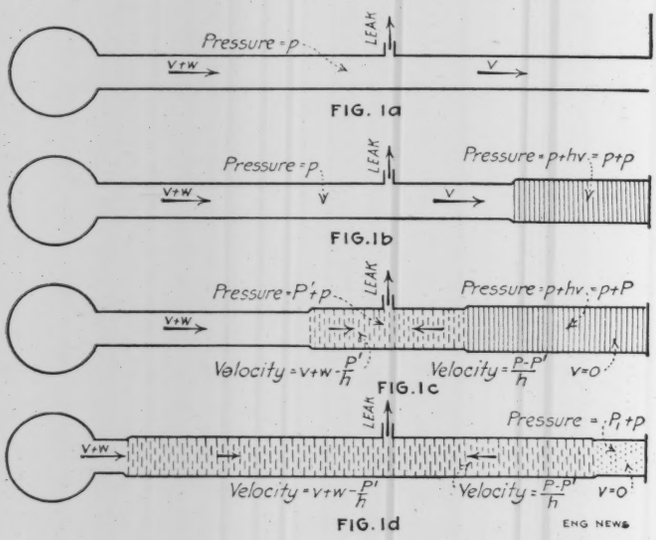
ELEVATIONS OF PUMPING EQUIPMENT AT BALDWINSVILLE, N. Y., SHOWING OLD AND NEW UNITS

The layout of the new pumping equipment was made by Carl Lager, Superintendent and Mechanical Engineer of the Morris Machine Works, Baldwinsville (which firm built and installed the units).

Locating Leaks in Water Mains by Means of the Water-Hammer Diagram*

By Melvin L. Enger†

When the valve at the end of a long pipe line is closed suddenly, great pressures may be caused. The term water-hammer has been applied to this phenomenon. If the valve could be closed instantly all of the water in the pipe would not be stopped at the same instant. The layer nearest the valve would stop first, then the next layer and so on until the impulse has traveled through



Figs. 1-a to 1-d. Diagrams Illustrating Pressures and Velocities on Closing Valve in Pipe Line Having Leak

the entire pipe line. As each layer of water is brought to rest, its pressure will, of course, be increased. The velocity of the transmission of the pressure wave will be the same as the velocity of transmission of sound in the water in the pipe, and will vary between 3400 and 4700 ft. per sec., depending upon the material of the pipe and upon the ratio of the thickness to the diameter of the pipe.

It has been found that for any given pipe, the amount of the water-hammer pressure is a constant times the extinguished velocity. The value of this constant (also called the water-hammer coefficient) varies directly with the velocity of transmission of the pressure wave, and for cast-iron pipe used for water-supplies has values between 45 and 63. For cast-iron pipe between 6 and 16 in. in diameter, the average value of the constant is about 55. That is, the water-hammer pressure caused by the sudden closure of a valve at the end of a long pipe line, in lb. per sq.in., is 55 times the velocity of the water in the pipe before the valve was closed, in ft. per sec.

Fig. 1a represents a pipe line in which there is a leak. The flow between the source (reservoir or large pipe) and the leak is $v - w$ ft. per sec., and between the leak and the valve is v ft. per sec. Fig. 1b shows the conditions in the pipe line a short time after the valve at the end is suddenly closed. The velocity of the water near the valve has been extinguished and its pressure increased hv lb. per sq.in. (h being the water-hammer coefficient). If the distance from the valve to the leak is l ft. and the velocity of propagation of the pressure wave is Z ft. per sec., the pressure wave will reach the leak l/Z seconds after the valve closed. Since the original pressure at the leak allowed a quantity of water equal to Aw cu.ft. per sec. to escape, it is evident that a higher pressure will cause a greater quantity to flow. The extinguished velocity between the leak and the source will therefore be less than v ft. per sec. Hence the water-hammer pressure generated in this part of the pipe line will be less than hv lb. per sq.in. A wave of reduced pressure will therefore travel from the leak toward the valve. Fig. 1c shows the conditions a short time after the pressure wave has passed the leak. The wave of reduced pressure will reach the valve $2\,l/Z$ seconds after the valve closed. Fig. 1d shows the conditions a short time after the wave of reduced pressure has reached the valve.

The water-hammer diagram is a graphical representation of the pressure in the pipe line near the valve for a time after the valve is closed. In the experiments made by the writer the diagram is obtained by having the pencil of an indicator trace on a sheet of paper wrapped around a drum driven at a uniform rate by an electric motor. Another pencil attached to an electro-magnet makes a time record. A view of the apparatus is shown in Fig. 2.

Fig. 3 shows the characteristic features of a water-hammer diagram taken at the end of a pipe line in which there is a leak. The first rise of pressure as the valve begins to close is shown at A. The indicator pencil reaches B when the valve is fully closed. The pressure then remains practically constant until the effect of the leak is registered at C. The distance $A'C''$ represents the time required for the pressure wave to travel from the

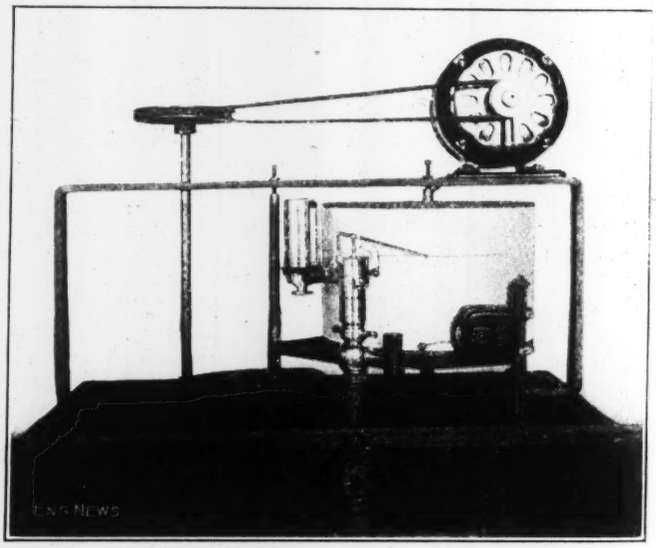


Fig. 2. View of Apparatus Used by M. L. Enger in 1906 to Obtain Water-Hammer Diagram

valve to the leak and back to the valve. If the velocity of transmission of the pressure wave is known, the distance from the valve to the leak is easily computed. The difficulty in the use of this method is in the determination of the velocity of transmission Z of the pressure wave. The velocity of the pressure wave will vary somewhat ac-

*A paper read before the Illinois Water Supply Association, March, 1914.

†Assistant Professor of Theoretical and Applied Mechanics, University of Illinois.

ding to the amount of air in the water. Another method which avoids the necessity of determining the value of Z is as follows: When the indicator pencil reaches E the first relief of pressure due to the source

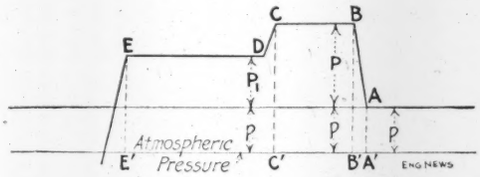


FIG. 3. CHARACTERISTIC FEATURES OF WATER-HAMMER DIAGRAM AT END OF PIPE LINE HAVING A LEAK

is felt. The distance $A'E'$ therefore represents the time required for the pressure wave to travel from the valve to the source and back to the valve. If the length of the pipe line from the valve to the source is L, the distance from the valve to the leak can be determined by proportion.

$$l : L :: A'C' : A'E'$$

In the writer's experiments, much more consistent results were obtained by this method than by the use of the velocity of transmission of the pressure wave and the time required for the pressure wave to go from the valve to the leak and return as scaled from the diagram.

The following values are taken from experiments made by the writer in 1906. The last two were measured from the second diagram shown in Fig. 5.

Calculated distance, ft.	Actual distance, ft.
64	72
70	72
371	381
385	381
375	381
262	265
265	265
116	113

The quantity of water discharged from the leak can also be determined from the water-hammer diagram. The expression for the velocity of flow in the pipe due to the leak is:

$$w = \frac{\dfrac{P - P_1}{h}}{\left(\dfrac{P + P_1}{2p} - 1\right)^{0.5} - 1}$$

P is the amount that the pressure is increased due to water-hammer, P_1 is the amount that the pressure at the valve is above the original pressure after the return wave from the leak reaches the valve; p is the original pressure at the valve; h is the water-hammer coefficient.

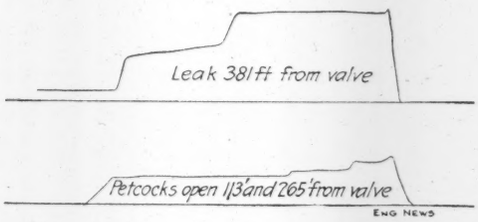


FIG. 5. WATER-HAMMER DIAGRAMS TAKEN BY M. L. ENGER AT UNIVERSITY OF ILLINOIS IN 1906

A number of values have been computed from the equation, and the results have been plotted in Fig. 4. It was assumed that $P = 55$ lb. per sq.in., $p = 40$ lb. per sq.in., and that $h = 55$. It will be seen from an examination of the curve that even small leaks will produce a noticeable fall of pressure on the water-hammer diagram.

The first suggestion that the water-hammer diagram could be used to determine the location of a leak was made by Prof. Joukovsky as the result of a series of experiments made in 1897 and 1898 for the water-works department of Moscow, Russia. He published a monograph (Stoss in Wasserleitungsrohren) in 1900. A translation of this paper, somewhat modified, was published in the Proceedings of the American Water-Works Association in 1904. Experiments were made by the writer in 1906, in the Hydraulic Laboratory of the University of Illinois. Fig. 5 shows two diagrams taken at that time.

In using this method for determining the location of a leak, the following suggestions are made. The quick-closing valve should be at the end of the section of pipe to be tested. This can be accomplished by tapping the main close to a valve, the valve in the main being kept closed during the experiments. The pipe leading from the main to the quick-closing valve must be large enough so that a water-hammer pressure at least as great as the static pressure can be caused by the sudden closure of the valve. The indicator should also be connected at this point of

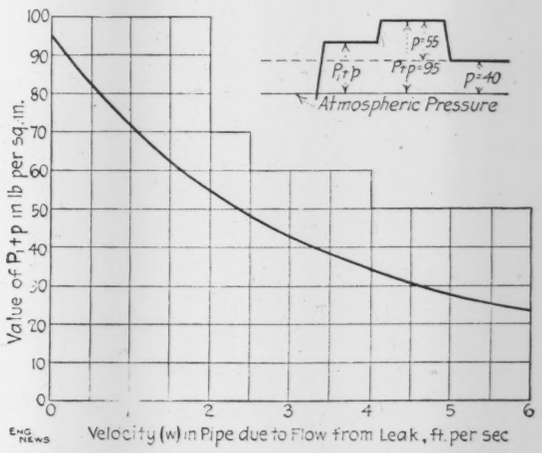


FIG. 4. WATER-HAMMER CURVE

the main, or to the pipe containing the quick-closing valve. If possible, the method of proportional distances should be used. The distance to the source (large main) should be measured. A hydrant partly open will make a good reference point in case the main on which the experiments are being made is very long. When the method of proportional distances is used, it is not necessary to know the speed of the paper. It is only necessary that the paper travel at a uniform speed while the diagram is being taken.*

Paying for Pavement Repairs and Renewals—A new paving law has recently gone into effect in Syracuse, N. Y., which provides that in case of a street paved with vitrified brick or blocks, or sandstone or granite blocks, a sum in addition to 33⅓% of the cost of surfacing, as fixed by the common council and approved by the board of estimate, to be equal to the cost of repairing at least 37½% of the superficial area of the paved surface, exclusive of the railroad strip, shall be borne by the city at large.

*For other recent articles on this same general subject see the following—Ed.:

"A New Device for Locating Leaks in Water Mains." [The Pulsograph.] Based on material from N. W. Akimoff and W. W. Brush. "Eng. News," Sept. 11, 1913; p. 515.

"A Diagram for Computing Water-Hammer Pressures." By Frank H. Carter. "Eng. News," Sept. 25, 1913; p. 616.

"The Calculation of Water Hammer Pressures." Letter from S. L. Berry, brought out by letter from Mr. Carter. "Eng. News," Dec. 4, 1913, p. 1144.

Methods of Flood Prevention

By John C. Oakes†

SYNOPSIS—Major Oakes is a member of a Board of U. S. Engineers, which has been for a year past investigating the flood of a year ago in the Ohio Valley and measures for preventing similar disasters in the future. His paper below discusses all the possible means of flood prevention and especially the reservoir system, showing the conditions which limit the use of reservoirs. The small value of undeveloped water power and the conflict between the use of reservoirs for flood storage and for power development and maintenance of low-water flow are shown. Finally, the work and conclusions of the Army Board on Flood Prevention are described.

In general, engineers fail to take the predominant part in the discussion of national problems to which their abilities and understanding entitle them. Their modesty seems to increase with success and attainments so that when the voice of one of them is heard on public questions, it is often likely to be that of the mediocre, the crank, or the man with an axe to grind, rather than that of the successful, studious and experienced practitioner. On such subjects as the construction and government ownership of railroads and public utilities, the improvement of harbors and waterways, and projects for flood protection, engineers are peculiarly fitted to form opinions and their knowledge on such subjects should make them the leaders of public opinion.

Flood-prevention measures must reduce precipitation, retard runoff, or increase the capacity of the channels. Runoff may be retarded by the retention of precipitation on or in the grounds, or by the use of reservoirs. Several means of holding the precipitation where it falls have been proposed, such as deep plowing, contour plowing and forestation. But, with a storm like that of March and April, 1913, where in certain localities on the Ohio, over 11 in. of precipitation occurred, it is very doubtful if more than a very small portion could be held in the soil, even if plowed deep.

Contour plowing is a term applied to the method of plowing which creates ridges following the contours of the land and forms, as it were, terraces in such a manner that water will be held where it falls. This method, or perhaps a modification of it by the use of small dikes, is used extensively in foreign countries such as Japan and the Phillipines where there is an excess of rain in one season to be followed later by a season of drought.

In the Eastern and Middle Western states, these measures are not necessary for agricultural purposes, and while, if used extensively, they would retard runoff to some extent, they are impossible of control by the United States.

This brings us to forestation. Even if it could be proven that forests exert, on the whole, a very beneficial effect, it is impracticable to convert fine agricultural land into forests.

Another objection to this method is that the formation of a humus sufficient to have its maximum effect in absorbing rainfall requires a very long period, probably at least a century. For these reasons, it seems to me unwise and inexpedient to advocate reforestation as a means of prevention of floods.

The last mentioned and most feasible method of retarding runoff is by the use of reservoirs. We have heard much of this subject within the last few years, and it has become a popular remedy for the prevention of floods. It is apparent to anyone that if the water of a flood can be held in reservoirs and allowed to escape slowly, no damage would occur. Therefore, without understanding the immensity of the problem, the ordinary man thinks he sees a remedy for floods and proceeds to become an advocate of what has come to be known as the reservoir method of flood prevention.

There are, without doubt, many localities that may be protected by a reservoir or reservoirs. For instance, the engineers employed by Dayton, Ohio, have announced their project for flood protection on the Great Miami River, where the conditions are stated to be particularly favorable for the creation of reservoirs. The drainage area above Hamilton is 3540 miles, and the reservoirs control about 2650 square miles. The dams vary in height from 50 ft. to 130 ft. The estimated cost is $17,000,000.

In like manner, several of the projects studied by the engineers employed by Columbus, Ohio, included reservoirs to detain one-third of the runoff. In these projects, the remainder of the runoff is to be taken care of by channels of increased capacity.

The Pittsburgh Flood Commission has studied the subject in connection with flood protection for their city, and they have evolved a plan which appears to provide against future disastrous floods at Pittsburgh. The drainage area above Pittsburgh is 18,900 sq.mi., and the estimated cost of the system is $34,000,000. However, there is grave reason to believe that this estimate is much too small.

These cases, particularly the first, represent the possible and practicable use of reservoirs, on small streams, where sites for high dams of small length may be found near the points to be protected. When one comes, however, to consider the prevention of floods in a river system like that of the Mississippi, or even of the large tributaries, the problem becomes exceedingly difficult.

Col. C. McD. Townsend, Corps of Engineers, U. S. Army, President of the Mississippi River Commission, in an address before the Drainage Congress in the spring of 1913, stated:

> To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Ill., having an area of 7000 square miles, slightly less than that of the State of New Jersey, and a depth of about 15 ft., assuming that the reservoir was empty when the river attained a bankfull stage. Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouths of the tributaries to the headwaters, their capacities must be largely increased.

It is not to be supposed that the people of Illinois and Missouri would be willing to have a portion of their territory as large as the State of New Jersey turned into a

*Greatly condensed from a paper read Apr. 21, before the Engineers and Architects Club of Louisville, Ky.

†Major, Corps of Engineers, U. S. A.

reservoir. In this connection, it should also be remembered that at the headwaters of the Mississippi, there is the largest artificial system of reservoirs in the world, with a capacity of 93,000,000,000 cu.ft. These reservoirs have been successful in slightly increasing the low-water discharge of the Mississippi River above St. Paul, and also in reducing floods in that portion of the river; but a hundred miles farther downstream, it is impossible to detect their influence during either high or low water.

The Ohio River, in which we are more particulaly interested, has a very large flood discharge. At Louisville, for instance, the maximum discharge is 790,000 cu.ft. per sec. At the mouth of the Ohio, the estimated maximum discharge amounts to 1,400,000 cu.ft. per sec. Let us see what effect the system of reservoirs proposed for the protection of Pittsburgh would have had at Louisville during the flood of March-April, 1913. The Pittsburgh Flood Commission proposed the construction and operation of seventeen reservoirs whose total capacity is approximately 59,500,000,000 cu.ft. The amount of water flowing past Louisville during the day of maximum height was approximately 67,392,000,000 cu.ft. The proposed reservoir system, therefore, would have been more than filled by one day's flow at Louisville, if we assume that the dangerous flood height at Louisville is 54 ft., then, to have kept the river below that height during that flood, a storage capacity of 7300 square mile feet, equal to 200,000,000,000 cu.ft., would have been required, or over three times the capacity of the proposed Pittsburgh system.

Another illustration may be taken from the Wabash River. The offices of which I have charge had just completed the field work of a survey of this stream between Terre Haute and the mouth at the time of the 1913 flood. To have reduced the flood height one foot during ten days would have required a reservoir capacity of 26,000,000,000 cu. ft., or a reservoir approximately 100 sq.mi. in area, with an average depth of 10 ft. To have kept the Wabash River within its banks at Mt. Carmel between the dates of Mar. 25 and Apr. 21, would have required a storage capacity of 260,000,000,000 cu.ft., amounting to 9300 sq.mi.-ft. This would have required a reservoir or reservoirs having an area of 930 sq.mi., with water at average depth of 10 ft.

If reservoirs are to be located on the headwaters of the tributaries, then sufficient capacity must be provided on each of the tributaries to allow for its maximum flood. This capacity will be many times the capacity estimated from the discharge of the main stream, because floods are generally caused by the flow from a number of tributaries, but seldom from the flow of all the tributaries at their maximum stage. Thus each individual tributary must be treated and reservoirs must be so operated that they will be empty when needed and when full they must be emptied slowly so as to prevent the piling up of water in the main stream.

A marked defect of this system is the possibility that one storm may follow another so closely that at the time of the second the reservoirs will be full and not available for storage purposes.

Reservoir sites are, in general, extremely costly. The Pittsburgh Flood Commission estimated the cost of its proposed system at $21,000,000, but a Board of U. S. Army Engineers, in reviewing the report, found that land and property damages were underestimated by $13,000,000, so if their other estimates were correct, the cost would be $34,000,000.

If a complete reservoir system were practicable for the Ohio River, some idea of its probable magnitude may be gained from the facts that the area of the basin of the Ohio Valley is 204,320 sq.mi., while the drainage area of the rivers above Pittsburgh just referred to is but about 18,920 sq.mi., or about 9% of the whole. Assuming that the cost per square mile would be the same as that for the Pittsburgh system, the total cost of providing reservoirs for the Ohio River would be $378,000,000.

However, the Pittsburgh project is based on the assumption that certain portions of the drainage area do not contribute excessively to floods at Pittsburgh and the projected reservoirs control only 10,152 sq.mi., or a little over one-half of the drainage area. May they not be mistaken? May not unusual conditions cause floods from the area not controlled by the projected reservoirs? My own opinion is that a project that controls only one-half the drainage area is not certain, and that there is grave possibility that floods may come from the uncontrolled territory. To really protect, the whole drainage basin must be considered, and if that should be done, the estimated cost of the Pittsburgh project would be $60,000,000, and basing our estimate on that amount, the cost of protecting the lower reaches of the Ohio would be about $600,000,000. This last estimate does not take into consideration the probable greater value of land and improvements in such states as Ohio, Indiana and Illinois. If we base our estimate on the cost of the reservoirs proposed about Dayton, the cost for the whole Ohio River Basin would be $992,000,000.

Is it advisable to start the Federal Government on a project of this magnitude for the Ohio River? How about the Mississippi, the Missouri, Tennessee, Cumberland, Arkansas, Red, the rivers on the Atlantic seaboard, the Colorado, Columbia, etc.? Where is the money to come from?

The advocates of reservoirs for flood protection for a large river like the Ohio, claim that the water stored in reservoirs may be used to produce power which may be sold to the public, thereby reducing the cost of flood prevention and may also be used to increase the low-water flow of streams, thereby improving navigation. In estimating the value of power, too, the theorists always assign to it a very high value.

A common fallacy, or perhaps it deserves a worse name, is to take the total fall of the river, an average discharge near the mouth, and then compute the theoretical horsepower, assume 80% of the theoretical as available horsepower, give it a value of $20 or $25, and thus arrive at the saving that may be made by storing the water and developing power. Such statements with a few "ifs" scattered in can be made to look well, but their effect on the unscientific reader is to convey an entirely false impression and are in effect unwarranted statements, particularly as the cost of the plant to be installed is never considered.

Many rivers with considerable fall and discharge, cannot be used to develop power commercially. The Ohio is an example, with its length of 967 miles, its total fall from Pittsburgh to Cairo of 420 ft. and enormous average flow, there is not a single point on the river where power can be developed as a commercial proposition. The only point worth investigating is at Louisville, and even

here the time has not arrived when water can compete with coal or gas for power. Mr. Leighton in advocating his reservoir scheme considered the conditions at Louisville as follows:

> It has been estimated that if the tributary basins were conserved up to their maximum, the fall at Louisville would be at least 22 ft. For purposes of safety we will consider only 18 ft. available. Now, the capacity of the reservoirs proposed in this paper, on the Ohio tributaries above Louisville, is such as to provide for a flow at Louisville during six months of the year, of 67,000 c.f.s. The unconserved drainage area above Louisville may safely be expected to provide at least an equivalent amount during the remaining six months of the year. Considering, then, an assumed flow of 67,000 c.f.s. at Louisville, and an 18-ft. fall, there is indicated an available horsepower of about 110,000. This figure involves only 80% efficiency on power wheels. This amount figured at $20 per horsepower-year, is equivalent to 3% income on $73,000,000.

Do you see how it is done? He makes certain assumptions that sound plausible enough to the reader who has no exact knowledge of existing conditions, assumes a value of $20 per horsepower-year, and arrives at a startling conclusion, which if true, would show a remarkable lack of business sense, not only among our officials, but among the business men and water-power experts of the country.

The average flow past Louisville last year was 75,000 cu.ft. per sec. During an ordinary year, it is probably about 67,000 cu.ft. per sec. According to his assumption, therefore, every cubic foot of runoff of the basin above Louisville would have to be conserved and regulated with particular reference to Louisville, so that exactly the average amount should flow by at every second of every day. If the flow should increase, the head would decrease, and the horsepower would decrease, as it would also if the flow decreased. Such control and regulation are impossible unless the reservoir dam be built at Louisville.

Again, power is not worth $20 per year except in very congested districts where the dams and power plants are already constructed. On the Kentucky River, we offered 1000 hp. average at each of three different dams, with 18-ft. head, for $1 per year per horsepower, and the project fell through. On the Muskingum, there are more than a dozen plants installed and taking advantage of the heads at dams in that river, and the rental varies from $2 to $4 per year per horsepower. I tried to raise the price slightly in several cases, and the users gave up their leases. The water-power question at Louisville has been investigated, and under present conditions it is not commercially possible to use it in competition with power developed from coal or gas.

Compare the price quoted above, $20 per annum for horsepower, assumed as the value to the United States by Mr. Leighton, and even higher prices assumed by less responsible writers with the following scale of prices adopted by the Department of Agriculture, Forest Service, in their power agreements for the use of water:

> The gross operation charge for any year shall be calculated as follows, by the Forester upon the basis of the quantity of electric energy generated in such year at a maximum rate which shall not exceed the following amounts per thousand kilowatt-hours (kw.-hr.): For the first year, 2c.; for the second year, 4c.; for the third year, 6c.; for the fourth year, 8c.; for the fifth year, 10c.; for the sixth to tenth years, inclusive, 12½c.; for the eleventh to fifteenth years, inclusive, 17½c.; for the twenty-first to twenty-fifth years, inclusive, 20c.; for the twenty-sixth to thirtieth years, inclusive, 22½c.; for the thirty-first to thirty-fifth years, inclusive, 25c.; for the thirty-sixth to fortieth years, inclusive, 27½c.; for the forty-first to forty-fifth years, inclusive, 30c.; for the forty-sixth to fiftieth years, inclusive, 32½c.

Reducing this to horsepower, developed at the busbars of the generators, the United States, according to this scale of rentals, will receive the first year 13.1c. per hp.-year; second year, 26c.; third year, 39c.; eleventh to fifteenth year, 97c., forty-sixth to fiftieth year, $2.13.

It will be noted that the average price is about $1 per developed horsepower-year, and this in my opinion is a fair price to assume in computing the value to the Government of power at sites where it is commercially possible to develop power. This is very different from the potential of a stream, or even the theoretical horsepower developable at a particular site.

It is true that reservoirs may be used for flood prevention and the water held therein used for power, or for increasing the low-water flow of a stream, but the full capacity of a reservoir may *not* be used for all three purposes at the same time. Reservoirs to be used for flood prevention must retain the water during the possibility of floods, but the instant that possibility passes the water must be allowed to escape as rapidly as possible without doing damage, in order that they may be empty at the time of the next possible flood. The use of reservoirs for increasing the flow of streams at low-water stages is just the reverse of this. They must be kept full as long as possible and the water only allowed to escape when it is absolutely necessary to increase the low-water flow. The use of reservoirs for power, on the other hand, requires a constant flow with a constant head to obtain the best results, and the more nearly these conditions are met, the more efficient is the plant and the greater income obtainable from a given expenditure.

A little thought on this subject will convince a reasonable man, that the three uses of reservoirs proposed by their advocates are incompatible one with the other, and in my opinion, if an endeavor were made to use the same reservoirs for these three purposes, it would not be long before the power interests would obtain control, and it would be practically impossible for a government agent to empty a reservoir in anticipation of a flood when the power interests desired the reservoir to be kept full in order to provide uniform power for their plant.

The capacity of streams may be increased by the use of levees, dredging or auxiliary channels.

Levees have been used for many hundreds of years. Large areas of the Mississippi basin are protected by levees. While it is true that breaks occur which cause vast damage, it is due to the fact that such levees have not been constructed with sufficient height and depth for protection against the greatest floods. Where a community felt itself too poor to provide against the highest floods, they have built their levees as high as their funds would allow, with the expectation and knowledge that when a higher flood came the levees would be topped. The Mississippi River Commission has elaborated a plan for levees, which, if carried out, should make the lower Mississippi Valley absolutely safe against overflow.

M. R. Jasmund, administration and construction councilor, in his description of the work on the Rhine, says:

> Whereas the levees used formerly to break regularly at high water, the fields were covered with sand, and many villages lay under water for a week at a time, it has become possible, in the course of the last 50 years, to improve the old levees so that they have become capable of greater resistance.

Dredging may be used for increasing the capacity of channels where the increase required is very moderate, but a radical increase in the capacity of a large stream

may not be accomplished by this method without the expenditure of enormous sums of money. A point oftentimes forgotten is that dredged material must be placed outside of the river channel if the dredging is to do any permanent good. This requires the purchase of lands upon which such material may be deposited, and increases the cost of actual dredging very materially.

Auxiliary channels have been suggested, both paralleling long stretches of streams and also to form cutoffs. The cost of providing additional channels for a stream like the Ohio or the Mississippi, of sufficient capacity to carry off the flood waters, is absolutely prohibitive. For the protection of a particular locality, short auxiliary channels or cutoffs may be used, but these have the disadvantage that while they may benefit the locality in question, by facilitating the runoff past that particular locality, they pile the water up more rapidly below, thereby causing more damage at other points as they necessarily cause steeper slopes, higher velocities and greater erosion.

We now come to the question of the prevention of damage by floods. The Board of which I am a member visited 66 different localities where the greatest amount of damage occurred as a result of last year's flood, and we found at almost every place visited that the damage was largely caused by artificial encroachments on the natural channels. For instance, many towns have grown up on the flood planes of the streams, occupying areas that have been overflowed from the beginning; people have entered the bottom lands and erected their structures with the knowledge that those lands were formed by silt, deposited by flood waters; railroads have constructed earth embankments across these bottoms, leaving only very narrow openings with wholly inadequate capacity for passing floods; city and county officials have built bridges with abutments projecting into the stream, with many piers of insufficient height, thus reducing the discharge area materially; individuals have dumped materials over the banks to increase the area of their property for business purposes.

These structures and encroachments have reduced the capacity of the streams, have formed partial dams which raise the water above previous levels and then by the breaking of an embankment or the washing out of a bridge the water held back has rushed downstream under increased head and velocity, destroying everything in its path. Aside from the damage done by the inundation of property, which, while serious, was not destructive, almost all of the damage at the points visited was caused by increased velocities of current due to the backing up of the water by embankments, bridges, and other structures, the subsequent breaking of these partial dams and the rush of the released waters under increased headsand and velocities.

The measures to be taken to prevent such damage are: in certain favored localities on the upper tributaries to use reservoirs wherever possible; to remove structures from the flood planes and river bottoms, or to elevate such structures above possible high water; to protect by levees valuable property which it is impossible to remove; to prevent the construction of heavy earthen embankments across flood plains by railroads or counties; to increase the capacity of channels by removing encroachments thereon in the shape of bridges, buildings, etc., and to remove all artificial and natural filling or deposits.

The work of the National Government along this line up to the present time has been limited. The principal work has been the construction of the levees on the Mississippi River. No other extensive work has been carried on for flood protection or flood prevention alone. At the time of the great flood of last year, the question arose as to the powers and duties of the General Government. There are at the present time no laws authorizing such works, unless they can be combined with works for the improvement of navigation.

In so far as floods interfere with navigation, there is no question as to the right of Congress to pass laws for the control of such floods. This power has been exercised in the past through the Engineer Department of the Army in charge of river and harbor districts, but has been limited in general to those stretches of the streams that are actually navigable. At the present time, we are regulating the heights and widths of bridges, preventing deposit of material over the banks of the streams or placing obstructions in the stream, etc. It would seem perfectly possible and within the power of Congress derived from the Constitution to authorize the extension of jurisdiction to all portions of navigable streams, whether actually navigable or not.

It would seem that the measure most needed at the present time is an act definitely authorizing some department of the Government to prevent the encroachments on the streams. If the Federal Government does not take up this question, it is within the power of the States to do so, and some measure or measures should be taken in each of the States to enable control of such matters.

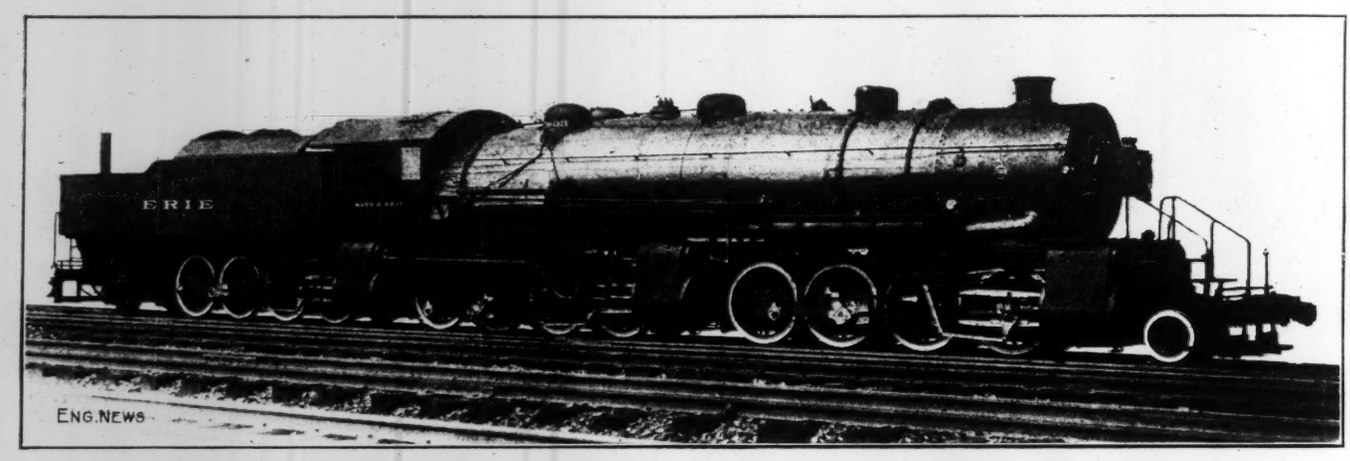
There are numerous cases where the people of the community have recognized the great danger involved in the construction of a bridge for instance, and where protests have been made, but without avail, because of the lack of laws under which any authority could act with hope of successful enforcement. It is a remarkable fact that in one of the towns of Indiana, certain county commissioners are constructing bridges across streams in direct opposition to a large proportion of the citizens of the town, the latter feeling confident that the bridges in question will cause great damage in the case of another flood, yet these citizens are unable to find any power that will enable them to prevent the construction of such bridges.

The Board of Officers, of which I am a member, is studying all conditions affecting flood prevention and protection of the Ohio River basin, and has collected practically all of the information available. It has recently recommended in its report than an appropriation be made for carrying on this work and for making surveys and plans for definite improvements of localities and streams.

The Board feels that the problem of prevention of floods in the Ohio River Basin is an immense one, whose difficulties are little understood by the mass of the people. Newspaper and magazine articles are describing and advocating measures without knowledge of what they will ultimately mean to the people, and we feel that the first duty of the Board is to obtain definite and precise information on all these subjects. We are not opposed to any method that will give relief and it is probable that when the matter is sufficiently studied it will be found that all of the methods described above may be used to advantage, and that each locality and each stream is a problem by itself, whose solution depends on local conditions and can only be determined when adequate knowledge is obtained.

The Most Powerful Locomotive Ever Built

By far the most powerful locomotive ever constructed has just been completed at the Baldwin Locomotive Works, for the Erie R.R. It is intended for pusher service on heavy grades, and is built after the patented designs of Geo. R. Henderson, Consulting Engineer of the Baldwin Locomotive Works. The distinctive feature of the design, as will be seen by the accompanying photograph, is an extension of the Mallet articulated compound principle. A third set of cylinders and driving wheels is placed under the locomotive tender, so that the weight of the tender becomes available for traction. In this manner, without materially increasing maximum wheel loads or the stress imposed upon bridge structures or the rigid wheel base of the machine, a locomotive has been built which utilizes substantially 90% of its total weight for traction purposes, including in this the weight of the tender. The ordinary Mallet compound locomotive, with its large tender, utilizes only about 65% of its total weight for traction. The advantage of this construction for operation on heavy grades is apparent. This is the first locomotive to be built from this patented design of Mr. Henderson's.



ARTICULATED LOCOMOTIVE WITH STEAM-DRIVEN TENDER, DESIGNED BY GEO. HENDERSON. BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE ERIE R.R.

Another notable feature of the design is that the cylinders are all of the same size, whereas in all other compound locomotives hitherto built, the low-pressure cylinders are much larger than the high-pressures. This result is obtained by the simple expedient of using the two center cylinders as high-pressure cylinders and the two end pairs of cylinders as low-pressure cylinders. This arrangement results in a compound locomotive in which the volume of the low-pressure cylinders is just double the volume of the high-pressure cylinders. The cylinders are 36 in. in diameter and 32 in. stroke; the piston valves controlling the distribution of steam to the cylinders are 16 in. in diameter. The manufacturing advantage in making all cylinders and valves from the same pattern is obvious.

The enormous boiler on this locomotive has a total water-heating surface of 6886 sq.ft. and a superheater of 1584 sq.ft., made up of 53 elements, by far the largest superheater ever applied to a locomotive. The barrel of the boiler is 94 in. in diameter at the front end, and 1/8 in. over 9 ft. in diameter at the dome ring. The center line is 10 ft. 7 in. above the rail. The circumferential seams of the boiler shell are triple-riveted, while the longitudinal seams have sextuple-riveted butt joints welded at the ends, giving a tensile strength equal to 90% of the solid plate.

The firebox is 13 ft. 6 in. long, of which the grates occupy 10 ft., and the combustion chamber extends in front of the grates into the boiler barrel. The tubes have a length of 24 ft. The firebox contains a brick arch supported on six 3½-in. tubes, and heated air is delivered under the arch by seven 3-in. pipes placed vertically in the bridge-wall. There are two fire-doors, and a Street mechanical stoker is applied.

From the superheater, the steam is carried to the high-pressure cylinders through outside piping. The entire locomotive is equipped with Baker valve-gear, and all three valve-gears are controlled simultaneously by the Ragonnet power-reverse mechanism.

In order to keep the weight of reciprocating parts within reasonable limits, the pistons are steel forgings of dished shape like a marine engine piston. Each forging is surrounded by a cast-iron bull ring carrying three piston rings. The cast-iron bull ring is secured to the piston head by a retaining-ring, which is electrically welded in place. The cylinders and steam chest are bushed, and these bushings, as well as the piston and valve packing rings are of Hunt-Spiller metal.

The pipes carrying the steam exhausted from the high-pressure cylinders to the low-pressure cylinders are made in the ordinary manner of flexible pipes in Mallet locomotives. Only half the steam is used for draft. The front end cylinders exhaust up the stack in the usual manner, but the draft from the rear cylinders under the tender is discharged up a pipe which is placed at the rear end of the tender. Use is made of this exhaust steam from the rear cylinders, however, to supply an exhaust-steam feed-water heater, consisting of a long drum traversed by small tubes. Through these small tubes the exhaust steam passes on its way to the rear stack.

In order to handle the hot feed-water from this heater, the locomotive is equipped in the old fashioned manner, with reciprocating pumps driven from the crossheads of the high-pressure engine. The locomotive is also equipped, however, with two injectors, which draw cold

feed-water from the tank. Both the pumps and injectors deliver to check valves placed near the front end of the boiler.

The tender section has frames, wheels, equalization levers and driving gear, arranged exactly like a steam locomotive. The tank is carried on this frame by six bearers, which serve also as transverse frame braces. The tank is 10 ft. 8 in. in width, and is placed sufficiently high to clear the valve-motion.

The joint between the middle section and the rear, or tender, section, is located under the cab, between the rear cylinders. The radius bar on the middle frame has a ball-joint connection with the hinge pin. A similar connection is provided between the middle and the front frame, and in this case the radius bar is attached to the front frame in such a way as to allow vertical flexibility. The frames of all the three sections are vanadium steel castings, 6 in. in depth. Each frame is cast in one piece with a single front section, to which the cylinders and saddle are keyed and bolted.

The front group of wheels is arranged with a continuous system of equalizing levers. The leading truck is center bearing and is equalized with the driving wheels after the manner usual in consolidation locomotives. The wheels under the second frame have a continuous equalization system on each side. In the rear group of wheels, the equalization is broken between the second and third pair of driving wheels. The trailing truck is of the side-bearing type, with outside journals, and is equalized with the two rear pairs of driving wheels. The usual arrangement of starting valve applied to Mallet locomotives is used also on this engine, with the exception that for starting, live steam is admitted to all four low-pressure cylinders.

The principal dimensions of this huge locomotive are given in the attached table. It will be seen from the table that the average weight on each driving axle is 62,800 lb. The weight of the locomotive per foot of total wheel base is 9220 lb. The weight per foot of total length over all is 7830 lb. The tractive force of the locomotive is given by its builders at 160,000 lb., which is between one-fourth and one-fifth of the total weight on the driving wheels.

Cylinders	
High-pressure, two	36x32-in.
Low-pressure, four	36x32-in.
Valves	Piston, 16-in. diam.
Boiler	
Diameter	94 in.
Thickness of sheets	13/16 and 1 in.
Working pressure	210 lb.
Staying	radial
Firebox	
Length	162 in.
Width	108 in.
Depth, front	87¼ in.
Depth, back	68 in.
Water space	
Front	6 in.
Sides	5 in.
Back	5 in.
Tubes	
Material	steel
Diameter	5½ and 2¼ in.
Thickness	5½ in., No. 9 W.G.
Thickness	2¼, No. 11 W. G.
Number	5½ in., 53; 2¼ in., 326
Length	24 ft.

Heating surface	
Firebox	272 sq.ft.
Combustion chamber	108 sq.ft.
Tubes	6418 sq.ft.
Firebrick tubes	88 sq.ft.
Total	6886 sq.ft.
Grate area	90 sq.ft.
Driving wheels	
Diameter, outside	63-in.
Journals	11x13⅛ in.
Truck wheels	
Diameter, front	33½ in.
Journals	6x12 in.
Diameter, back	42 in.
Journals	9x14 in.
Wheel base	
Rigid, each group	16 ft. 6 in.
Driving	71 ft. 6 in.
Total	90 ft.
Tank	
Water capacity	10,000 gal.
Coal capacity	16 tons
Weight	
On all driving-wheels	753,600 lb.
On truck, front	32,050 lb.
On truck, back	59,400 lb.
Total	845,050 lb.

This enormous tractive power would be apt to play havoc with the couplers and draft gear of the average freight train, if the locomotive were not used with care and skill. We understand that the locomotive has been purchased by the Erie R.R. for pusher service in operating steep grades on the Susquehanna division. The usual way of using such heavy locomotives as pushers is to place the locomotive somewhat back of the center of the train, so that it will assist the road locomotive ahead in handling the cars in front of it, and will itself haul the rear portion of the train. In this way, the tractive power of the locomotive is divided between the cars in front and those behind, thus keeping down the draft-gear stresses.

The Science of Development*

By John R. Hewett

We are apparently fast coming to recognize that there is such a thing as "a science of development" and that such a science among other factors must include the following fundamentals:

(1) An accurate determination of the actual operating conditions which will enable us to settle definitely what is wanted.

There are, perhaps, many who do not realize the costliness of determining what is wanted to suit a particular set of service conditions. An accurate determination of the precise requirements will often necessitate months of exhaustive investigation, often including costly tests. This is particularly true in large undertakings. If we compare the work done in this direction today with the older haphazard methods of designing machinery first and seeing whether it would do the work afterward, it is apparent that the art has benefited enormously by the work of the large corporation along these lines. Some phases of the research and development work undertaken today are so costly and require such a large staff of expert workers that no small engineering undertaking could shoulder the burden, as assumed by the large corporation.

(2) The coördination of the work of a large number of differently trained men, so that the finished product may embrace the experience of each worker in his particular line, and thus become in every detail the product of experts.

The proper coördination of the work of a host of men who are contributing to the design, manufacture and testing of electric railway apparatus is no small part of the Science of Development. The extent of this work is enormous, including as it does, preliminary proposition, final proposition, designing, drafting, actual manufacture and work incident to following apparatus through the factory, assembling, testing, installing, and preliminary operation. The final cost of the apparatus depends largely upon whether this coördination of work is done in a scientific or unscientific manner.

(3) The confidence and coöperation of the users and makers of apparatus both before and after its manufacture, this coöperation to continue in some form or other during the useful life of the machine.

A whole paper might be read with profit on the subject of the confidence and coöperation between the user and the maker. The manufacturer is dependent upon the user just as the user is dependent upon the manufacturer. An ounce of mutual confidence and coöperation will do more toward the development of the art than a ton of fault finding and mutual distrust. In the broadest sense, the aims and objects of both parties are identical. The user wants the best obtainable for his service and the maker wishes to produce the best and most efficient apparatus, as upon this his reputation and future business depends.

(4) The standardization of apparatus when such will be profitable to all concerned.

The correct time at which the standardization of electric apparatus should be attempted is a science in itself. When any art has been developed to a reasonable state of perfection and after the process of eliminating the less suitable factors and perfecting those which have shown themselves capable of meeting the necessary demands, under actual service conditions, has been carried to the point where our knowledge, based on experience, enables us to retain the good and reject the bad—then and not until then, is the time to talk of standardization. An attempt at standardization when an art is in a more or less embryo state is likely to work a permanent harm inasmuch as it limits our knowledge of the broader engineering possibilities that might be

*From a paper on "The Development of Electric Traction" in the "General Electric Review."

brought to bear upon the subject. It would undoubtedly be profitable to all concerned if all trolley systems would co-operate with the manufacturers in using standard apparatus, especially standard railway motors and standard control equipment, where such standards will fulfill the requirements. There will, however, always be special conditions arising that will demand special apparatus, and the things that dictate these special requirements are many and varied.

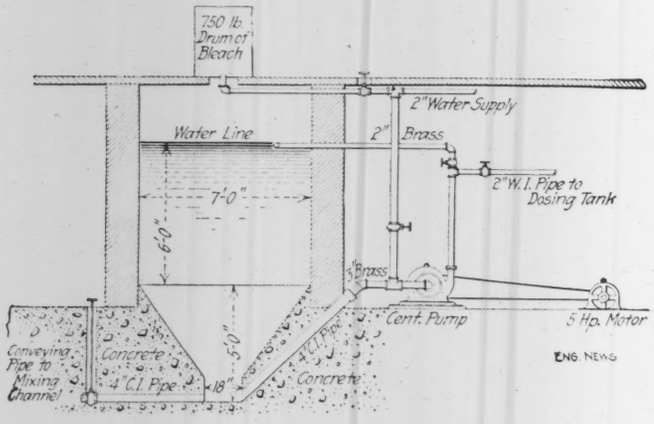
Who could have foreseen that the fashion of ladies' skirts could affect the design of railway motors? But such has been the case—the hobble skirt gave birth to the low-step car—and the low-step car required a new design of motor.

In conclusion, it is well to emphasize one point, namely, that modern engineering involves, above all things, the study of economics. Yesterday we were finding out how to do things—today we are striving to find out how to do them more cheaply than yesterday.

To combat the increased cost of living and of labor, etc., and the generally more complicated social and commercial conditions under which we are living, the work of the scientist and the engineer is to teach the world at large how to do for one dollar that which they could not do for two dollars yesterday

Hypochlorite Mixing Tank for the Providence Sewage-Disposal Works

A brief account of the use of hypochlorite for the treatment of sewage at Providence, R. I., during the year 1912 appeared in our issue of Dec. 25, 1913, p. 1292. The following description and accompanying illustration of the hypochlorite mixing tank at Providence are taken from the recently published annual report of Otis F. Clapp, city engineer of Providence:



HYPOCHLORITE MIXING TANK, PROVIDENCE SEWAGE-DISPOSAL WORKS

When the disinfecting of sewage was begun, the bleaching powder was mixed in the old shallow tanks formerly used for mixing milk of lime. These tanks did not prove entirely satisfactory for various reasons, chief among which was the annoyance caused the operatives by the dust, which attacked the membrane of the eyes, nose and throat.

A new form of tank, which was put into operation about July 1, 1912, has proved very satisfactory.

The tank is cylindrical, having a bottom shaped like an inverted hollow cone. It is built of brick, and is covered by the floor above, which is placed directly on the top of the tank, thus forming a tight joint between the walls of the tank and the under side of the floor. [See cross-sections for dimensions, connections, etc.—Ed.]

The discharge pipe from the pump is 2 in. in diameter, and connects with both the mixing and the dosing tank. It connects tangentially with the mixing tank at a point near the surface of the solution. By closing the valve leading to the dosing tank, and opening the valve leading back to the mixing tank, it is possible to pump the solution over and through the tank, thus thoroughly mixing the bleaching powder with the water, after which it is pumped to the dosing tank.

There is an opening 18 in. in diameter in the floor, directly over the center of the mixing tank. Pointing upward to the center of this opening is a 2-in. water pipe.

The bleach is purchased in metal drums containing about 750 lb. each. When it is desired to make up a tank of bleaching-powder solution, a hole about 8 in. in diameter is cut in the bottom of one of these drums, which is then placed over the hole in the floor, so that the 2-in. water pipe points into the center of the opening of the drum. The water is then turned on, and the bleach is washed out of the drum into the tank below, without the escape of any dust into the room.

The tank is then filled to the proper level, and the liquid is kept in circulation for one hour, after which it is pumped into a dosing tank and diluted to a strength of 25 lb. of bleach per 100 gal. of water, equivalent to approximately a 3% solution of bleach or a 1% solution of available chlorine. The rotary motion imparted to the contents of the mixing tank by the discharge from the centrifugal pump causes the solution to be so thoroughly mixed that further stirring in the dosing, while being applied to the sewage, is unnecessary.

Two Reinforced-Concrete Water-Works Tanks, each of them 66 ft. in diameter and 20 ft. deep, have been built at Gaya in India and are described in "The Engineer," London. The thickness of the reservoir walls varies from 1 ft. 8 in. at the bottom to 9 in. at the top. The reinforcement consists of ¾ in. diameter round bars spaced two inches apart at the bottom and 9 in. at the top. The concreting of the walls was started about the end of February, 1912, just at the beginning of the extremely hot weather. Gaya is one of the hottest places in Eastern India, and the maximum temperature on the hill where the reservoirs stand, surrounded by bare rocks which reflect the heat with great intensity, probably reaches nearly 160° in the sun during the hottest weather. Moreover, a dry west wind usually blows strongly in the daytime from the end of March onward. Notwithstanding these difficult climatic conditions, the reservoirs were constructed successfully. The inside was after completion plastered with 1:1 cement plaster ¾ in. thick, and the outside with cement plaster made up of three sand to one cement ½ in. thick. After the reservoirs were filled some moisture appeared on the outer face but apparently from general porosity rather than from any well defined leak. Most of these porous places have since become closed and the reservoirs are now practically water-tight. An interesting feature of the work was the method by which the concrete was transported after mixing to its place in the walls. A large number of female coolies were engaged who carried the mixed concrete in small buckets on their heads. A bamboo staircase was built inside the reservoir wide enough for a stream of coolies coming in one direction to pass the stream returning.

Notes from Engineering Schools

YALE UNIVERSITY—Prof. L. P. Breckenridge, Dean of Sheffield Scientific School, has announced plans to open a course in aeronautics for the study of all phases of scientific flying.

TECHNOLOGY-HARVARD—Courses in highway engineering have been established by the coördinated engineering schools of Massachusetts Institute of Technology and Harvard University. In the Department of Civil Engineering, there have been previously options in railroad or hydraulic and sanitary engineering; the new course is an option of equal rank for the specialization of men grounded in engineering fundamentals. The departure from other civil-enginering courses commences in the third year and is marked in the fourth. There is, for instance, less study of electricity and more of chemistry, less of railroads and more of road building. All these courses are undergraduate.

NEWS NOTES

A Street-Car Derailment Killed Six Persons and injured about 20 on Apr. 19 at Saginaw, Mich. The car turned over on its side and slid 20 ft., crashing into an iron pole.

A New Bridge Was Washed Out, over Bonpas Creek, near Mt. Carmel, Ill., by a recent rain. The bridge piers were washed down stream and the banks of the creek were scoured.

Forest Products Exposition—This will be held May 21-30 in the Grand Central Palace, New York City, and will be an enlargement of the exposition held in the Chicago Coliseum Apr. 30-May 9. Congress has voted $10,000 for an exhibit of the Forest Service. It is sought to teach the value of forest preservation.

Concrete Pavements at Macon, Ga., laid during the past two seasons have given such satisfaction that about 20,000 sq.yd. will be put down this season. The work will be done by city force under the direction of J. J. Gaillard, City Engineer. A 1:2½:3 concrete is used, in a single 8-in. course. Previous work has cost $1.80 per sq.yd., as against $2.20 for brick. A small portable concrete mixer has just been bought.

"Insurance Day" was celebrated in San Francisco on the grounds of the Panama-Pacific Exposition on April 18, the eighth anniversary of the conflagration which swept over the city in 1906. A spectacular test of the Exposition's fire-fighting apparatus was made, assisted by streams from the municipal fire boats. The fire streams were thrown over the recently completed Palace of Machinery, 136 ft. high.

Gate Accident on Welland Canal—Three gates of Lock 4, St. Catherine, Ont., were carried away on Apr. 30, by the steamer "Compton" of the Hall Forwarding Co., Montreal, Que., bound for Ashtabula. The "Compton" entered the lock at some speed and pushed the headgates open. They returned unevenly, failing to miter, and were torn from their fastenings by the rushing water and dropped with the steamer to the level below.

Valuation of Street Railways in the District of Columbia has been ordered by the District Commissioners acting as a public-utility-regulation board. A contract for the valuation work has been given to Prof. E. H. Bemis. The latter has announced, as his assistants, C. L. Pillsbury, of Minneapolis, engineer, Andrew Sangster and Robert McArthur, of Chicago, accountants. The work is expected to take until Jan. 1, 1915.

The Commissioners are reported also to favor the Crosser bill providing for municipal ownership of these lines.

Spring Floods in Texas—Three days of heavy rain have caused the U. S. Weather Bureau to send out warnings to low-lying districts of northern Texas. Flood warnings were issued for the Olmos Valley, near San Antonio. From 2 to 6 in. precipitation was reported over the entire northern part of the state. Weakened trestles and washouts have interrupted railroad schedules. A Dallas man was drowned on Apr. 27, according to press dispatches. A 200-ft. bridge near Dallas, with an 80-ft. steel span and wood approaches, was washed out.

The Locating Engineers for the Alaska Railways, to be built by the United States Government, were selected during the past week by the President, as announced in our "Personals" column on a following page. No official announcement has as yet been made as to the organization of the engineering forces, the method of appointing the lower grades of engineers or the procedure to be followed in the location of the new lines. It is expected that the three engineers appointed to head the locating work will meet immediately and proceed to an organization.

Making Metal Tubing by electrically welding heated skelp is the subject of a patent issued to Elias E. Ries of 116 Nassau St., New York City, on Apr. 14. The process covered by the patent, it is stated by Mr. Ries, has been demonstrated experimentally at a mill in Pennsylvania and involves the imparting of heat to the skelp as it travels through the rolls by a series of revolving contacts conveying low-tension electric current. It is claimed that by imparting the heat in this manner and concentrating it especially upon the edges to be welded, tubes and pipes can be produced by a continuous process from the original ingot or billet to the finished pipe without allowing the material ever to grow cold.

Large Concrete Bridge Over Miami River—The Butler County Flood Emergency Commission in joint session with the County Commissioners on Apr. 27 awarded the contract for the construction of the viaduct and bridges over the Great Miami River on the levee road west of Middletown, Ohio, to the Hackedorn Contracting Co., Indianapolis, at $255,000 on plans submitted by them.

This contract comprises the largest single piece of bridge construction replacing damages of last year's flood in the Miami Valley and is 1921 ft. long. It is arch construction, reinforced concrete throughout, the arches ranging from 70 ft. to 110 ft. The contract is to be completed before Jan. 1, 1915. Bids were received on steel and concrete construction. The low bid on steel was $190,000.

Heavy Excavation Timbering Collapsed in Brooklyn, N. Y., on May 1, from the impact of a two-ton concrete bucket falling on a concrete hopper which rested on two wood trusses, which were bracing the open cut. These trusses with the hopper and concrete fell to the bottom, 26 ft. below, injuring four men. The soil is a stiff clay. At the excavation (for the New York Connecting Ry.) it is retained by sheet piling held by 10x10-in. timber bracing on 10-ft. centers, extending across the 70-ft. cut. W. H. Gahagan, Inc., the contractor, states that the accident was due to the carelessness of the hoisting and signal men. The bucket (weighing with concrete 11,100 lb.) was lowered too far, striking the hopper.

Over 5,000,000 Cu.Yd. of Concrete on One Job—The amounts of concrete laid in the major features of the Panama Canal and its auxiliary works to Mar. 1, 1914, are, as follows:

Item	Cubic yards
Gatun Locks	2,068,424
Miraflores Locks	1,506,563
Pedro Miguel Lock and Dam	929,232
Gatun Dam and Spillway	232,256
Miraflores Dam and Spillway	79,004
Pedro Miguel-Miraflores duct line	6,193
Central Division	1,271
Balboa terminals	69,996
Cristobal terminals	63,785
Hydroelectric station	14,323
Transmission line	6,939
Aids to navigation	*5,000
Relocated Panama R.R.	63,123
Permanent buildings, Balboa	7,202
Total	5,053,311

*Approximate.

Including the work on fortifications, the pontoon barge piers at Paraiso, Quartermaster's construction, municipal engineering, etc., the total concrete placed by the American Canal forces is well above 5,000,000 cubic yards. ["Canal Record."] This is equivalent to a cube 513 ft. on a side.

Brick and Asphalt Block Pavements at Savannah, Ga., are laid on a carefully prepared natural earth foundation. According to E. R. Conant, Chief Engineer of the City of Savannah, this soil is, with few exceptions, well drained sand mixed with loam or clay, and, when thoroughly rolled or tamped, gives such good results as a foundation as not to warrant the use of a concrete base where the traffic is light or medium. The pavement subgrade is shaped roughly, finished with a steel-lined wood-drag and tempered with water. The brick or asphalt blocks are laid directly on the subgrade, and the points are filled with sand. Brick have been laid on edge heretofore, but laying flatwise is under consideration. Unevenness in brick pavements in Savannah, Mr. Conant states, is due not to a yielding of the foundation, but to the wear of the brick. Last year some of the old brick pavements were taken up and turned and relaid, and about 10% of the total replaced with new brick, all at a cost of about 30c. per sq.yd. The average cost of brick pavements for ten years past at Savannah, laid as above, has been $1.55 per sq.yd., including a slight amount of grading and also granite curbs. Last year 20,000 sq.yd. of asphalt blocks were brought in by water from Maurer, N. J., at a cost of $1.26 per sq.yd. at Savannah. Grading, in some places to a depth of 1 ft., laying and granite curbing brought the total cost up from $1.80 to $2.05 per sq.yd. The curb cost about 23c. per lin.ft. The yardage and mileage of improved streets in Savannah at the close of 1913 was as follows:

	Sq.yd.	Miles
Sheet asphalt	140,814	5.4
Asphalt block	304,585	11.3
Vitrified brick	337,565	15.6
Granite block	96,646	4.1
Cobblestone	110,000	5.5
Granite	50,000	3.1
Shell, cinders, etc.	12,000	1.0
Total	1,051,610	46.0

The estimated length of unimproved streets was 90 miles.

A New Locomotive Superheater has been developed by the Power Specialty Co., 111 Broadway, New York. An experimental installation of this superheater was put in service on a Pennsylvania R.R. locomotive over two years ago, and it is stated that the superheater has never caused delay or trouble on the road and has shown durability under hard service.

The header used in the superheater is of openhearth steel instead of cast iron. The tubular elements of the superheater are expanded in holes in the cylindrical steel header, eliminating all trouble with ground joints. Each horizontal row of elements is clamped by a U-bolt to a transverse bar, which is securely bolted to the smoke-box shell.

The Population of the United States on July 1, 1914, will be 109,021,992, according to estimates made by the Bureau of Census, Washington, D. C. The estimates were made on the arithemetical basis of increase between 1900 and 1910, which method was adopted by the Bureau of Census a number of years ago after careful study of all available methods for computing population for intercensal years. The figure given above is for the United States and its possessions. For continental United States alone the 1914 population is estimated to be 98,781,342 as against 91,972,266 returned as of Apr. 15, 1910. The Bureau of Census will soon publish a bulletin giving estimates of population on July 1, 1914, for the years to 1910 for each state in the Union and for cities which had 8000 population or more in 1910.

Service Tests of Bronze Journal Bearings for Railway Rolling stock have recently been conducted by the American Metal Co., Pittsburgh. Solid bronze castings were made without babbit surface; the material was 65% copper, 30% lead and 5% tin. A 22-lb. bearing was placed under the tender of Baltimore & Ohio locomotive No. 2127 (Pacific type). It was examined after 51,000 miles run and found worn down $\frac{5}{32}$ in.; the other tender bearings were each rebabbited six times.

This bronze, it is claimed, can be hardened for mill brasses; tests of such bearings were made by placing two 75-lb. brasses under the rolling table of an 108-in. plate mill in the Soho plant of Jones & Laughlin, Pittsburgh. They gave continuous service for four weeks which is claimed to be twice as long as phosphor bronze bearings used. These parts cannot be lubricated on account of position.

Action By Grand Jury on New York State Highway Investigation—The Albany County grand jury, which has been in session for several weeks to investigate alleged graft in road repair work, failed to return indictments against State Engineer, John A. Bensel; State Superintendent of Public Works, Duncan W. Peck; former State Highway Commissioner, C. Gordon Reel, and Deputy Highway Commissioner, Charles F. Foley. Four sealed indictments, however, were delivered to the court, which are rumored to be against the contractors involved. The grand jury adopted the following resolution:

The findings which were submitted were arrived at after a most careful consideration of the testimony taken by Commissioner James W. Osborne, which was submitted to the Grand Jury by the District Attorney, and after an examination of numerous witnesses and experts.

We, the members of the Grand Jury, find that the Highway Commission, as organized during the period covered by the evidence, was in effect single-headed, although in the form of a commission, and that two members of the commission, the State Engineer and the Superintendent of Public Works, were, by the statute, simply to act in an advisory capacity, and that the requirement of their offices precluded any other possibility, and they are therefore, in our opinion, entirely free from any properly direct criticism in regard to the conditions to which the attention of the Grand Jury of Albany county was called.

Hauling Heavy Concentrated Load by Auto Truck—A 40-ton armor-plate bank-vault vestibule, claimed by the Bethlehem Steel Co. to be the largest ever built, was unloaded by derrick from a large lighter at the foot of Wall St., East River, New York City, onto a truck. It was intended to haul this load by a new gasoline-hydraulic truck used as a tractor, recently bought by the Bethlehem Steel Co. for use at its iron mines in Chile. The haul from South St. to the National Park Bank, Broadway and Fulton St., was to have started at 2 p.m. on May 2, but an accident to a valve guide of the new truck made it necessary to substitute another (a 6-ton LaFrance gasoline-hydraulic).

When the piece was lifted from the lighter to the trailer truck, the lighter listed at least 15°. After the piece was securely fastened on the truck, the wagon tongue was pulled around to an angle of 45° and a shorter tongue substituted. A steel cable was attached to the rear axle, run through a ring at the extremity of the tongue, and attached at two points by means of U-connections to the rear axle of the tractor truck.

The motor truck was unable to start the load. The heavy weight caused the flooring of the load truck to foul one of the wheels. The load at this point was jacked up and a 5-ton Sampson truck hooked to the first one. The load was then started without difficulty. After this the first truck was able to pull the load without the assistance of the other. The other truck kept its position, however, and there were times when the united efforts of the trucks were required to keep the load in motion.

The moving was done under the direction of the Terry Construction Co., who is erecting the vaults and steel work for the bank. The motor trucks were furnished by the Hydraulic Sales Co., 1777 Broadway. The load started at 2 p.m., and reached the site at 5 p.m. The route was along South St. to Fulton, up Fulton to Broadway, to site—a distance of about ½ mile.

For the greater part of the route the pavement was granite-block, and no difficulty was met until the trucks slowed down to turn into Ann St. In turning, one of the 9-in. cast-steel wheels of the load truck sank into the asphalt there about 4 in. The wheel was jacked up and the trip completed.

PERSONALS

Mr. F. Von Sprecken has been appointed Assistant Engineer of the Atlantic Coast Line R.R., with headquarters at Savannah, Ga.

Dr. J. S. Neff, Director of Public Health of Philadelphia, Penn., since 1907 has resigned because of ill health. He recently suffered from a severe illness and is unable to bear the strain of his official duties.

Mr. H. H. Shepard has been appointed Superintendent of the Buffalo division of the Delaware, Lackawanna & Western R.R., with office at Buffalo, N. Y., succeeding Mr. L. J. Ferritor.

Mr. Ernest Gonzenbach, formerly President and General Manager of the Sheboygan (Wis.) Railway & Electric Co., has been appointed General Manager of the Empire United Rys., Inc., of Syracuse, N. Y., which is a recent consolidation of several electric lines centering in Syracuse.

Mr. Benjamin Campbell, Vice-President of the Boston & Maine R.R., has resigned. Mr. Campbell was the last of the New York, New Haven & Hartford R.R. officials to hold office in the operating departments of the Boston & Maine R.R.

Mr. J. M. Rapelje, General Superintendent of the Northern Pacific Ry., at Livingston, Mont., has been promoted to be Assistant General Manager, with headquarters at St. Paul, Minn. He is succeeded as General Superintendent at Livingston by Mr. A. V. Brown, former Superintendent of the Lake Superior division at Duluth, Minn.

Mr. L. C. Whitsit, recently Chief Draftsman of the bridge department of the Michigan Central R.R., has been appointed Assistant Engineer in charge of sewers and water-works of the village of Highland Park, Mich., a suburb of Detroit. Mr. Whitsit is a graduate of the University of Michigan, class of 1907.

Mr. Robert L. Clemmitt, Assistant Water Engineer of Baltimore, Md., has been appointed Acting Chief Engineer and President of the Water Board to succeed Mr. Ezra B. Whitman, M. Am. Soc. C. E., resigned, as noted in our issue of Mar. 19, 1914. It is reported that Mayor Preston will leave the appointment of a permanent head of the department to his successor.

Mr. Santiago Mendez, formerly Consulting Engineer of the National Rys. of Mexico, has been elected Vice-President and acting head of the system. He was born in Mexico City in 1853 and graduated at National School of Engineers of Mexico in 1875. He has been connected with the National Rys. of Mexico since the construction of many of the earlier railways which became the nucleus of the system.

Brig.-Gen. William Crawford Gorgas, Surgeon General, U. S. A., was presented on Apr. 28, with the Doctor Louis Livingston Seaman Medal of the American Museum of Safety, "for his discoveries and achievements in the science of sanitation and their application in making the Panama Canal Zone inhabitable with health and safety." Gen. Gorgas has previously been awarded at least two gold medals for the same achievements.

Mr. Robert Van Buren, M. Am. Soc. C. E., Borough Engineer of the Department of Water Supply, Gas and Electricity, Brooklyn, N. Y., has filed an application for retirement on half pay. Mr. Van Buren entered the service of the water department of the old city of Brooklyn in 1865, and for 49 years has been continuously connected with the Brooklyn water-works. He laid out much of the original water-main system.

Mr. R. C. Cole has accepted a position with the pneumatic tool department of the Ingersoll-Rand Co., at Chicago, Ill.

Prof. R. H. Fernald, M. Am. Soc. M. E., of the University of Pennsylvania, has been appointed Consulting Engineer of the United States Bureau of Mines in connection with the general technologic investigations now being carried on by the Bureau. It is expected Prof. Fernald will be sent to Europe to investigate and report upon recent improvements in gas producers for metallurgical and power purposes. Prof. Fernald will probably visit England, France, Belgium, Germany and Austria.

Mr. Henry Raff, M. Am. Soc. C. E., has resigned as Principal Designing Engineer of the Concrete-Steel Engineering Co., New York City, and has opened an office in the Park Row Bldg., New York City, as Consulting Engineer, specializing in the design and supervision of construction of reinforced-concrete arch and girder bridges and all kinds of reinforced-concrete work. Mr. Raff and Mr. Edwin Thacher, M. Am. Soc. C. E., will serve each other as Associate Engineers.

Mr. M. T. Montgomery, former Superintendent of Tramways of the Monterrey Railway, Light & Power Co., Monterrey, Mex., was one of the American refugees who arrived in safety at Brownsville, Tex., Apr. 30. Mr. Montgomery is reported to have said that he was sentenced to be shot by the Mexican Federals at 2 o'clock on the morning of Apr. 24. Fifteen minutes before the time set for his execution the rebels entered the city and his would-be executioners fled. Mr. Montgomery was accused of having aided the rebels.

Mr. Douglas I. McKay, who resigned as Police Commissioner of New York City about a month ago, has become Assistant to the President, J. G. White & Co., of New York City. Mr. McKay is a graduate of West Point and served some time in the United States Army prior to his appointment by Mayor Gaynor as First Deputy Police Commissioner of New York. Pending the appointment of a permanent Commissioner by Mayor Mitchell, he served as the head of the department.

Mr. W. G. Besler, Vice-President and General Manager of the Central R.R. of New Jersey, has been elected President and General Manager to succeed the late George F. Baer. Mr. Besler was born in Galesburg, Ill., in 1864. His railway experience began in 1880 as a trainmaster's clerk on the Chicago, Burlington & Quincy R.R. He was Division Superintendent of the Philadelphia & Reading Ry. from 1900 to 1902 and General Superintendent in 1903. Since 1903 he has been Vice-President and General Manager of the Central R.R. of New Jersey.

Mr. Ralph Budd, M. Am. Soc. C. E., recently Chief Engineer of the Great Northern Ry., has been again appointed Assistant to the President of the company, and Mr. A. H. Hogeland, M. Am. Soc. C. E., recently Consulting Engineer and formerly Chief Engineer, has been reappointed Chief Engineer. Mr. Budd was formerly Chief Engineer of the Panama R.R., and later was Chief Engineer of the Spokane, Portland & Seattle Ry. until January, 1913, when he came East to be Assistant to the President of the Great Northern Ry.

Mr. Frederick W. Cowie, M. Can. Soc. C. E., Chief Engineer of the Harbor Commissioners of Montreal, Que., has been awarded the Telford Gold Medal of the Institution of Civil Engineers of Great Britain for his paper "Transportation Problems in Canada and the Montreal Harbor." Mr. Cowie has been a member of the Institution since 1908. He graduated in civil engineering from the McGill University in 1886 and for a number of years served under John Kennedy, Chief Engineer of the Montreal Harbor Commissioners. In 1892 Mr. Cowie was appointed Assistant Engineer of the Public Works Department of Canada. From 1897 to 1903 he was Resident Engineer of the River St. Lawrence Ship Canal.

President Wilson has appointed Mr. William C. Edes, M. Am. Soc. C. E., Chief Engineer of the Northwestern Pacific R.R., San Francisco, Calif., Lieut. Frederick Mears, Assoc. M. Am. Soc. C. E., General Superintendent of the Panama R.R., Cristobal, C. Z., and Mr. Thomas Riggs, Jr., Assoc. M. Am. Soc. C. E., recently Engineer to the Commission on the Alaska Boundary Survey, and of the Coast and Geodetic Survey, members of the Alaska Railway Commission, which is to select routes for the railways to be built by the government under the act passed and signed by the President, Mar. 12 last, appropriating $40,000,000 for that purpose. Mr. Edes was born in Bolton, Mass., in 1856, and graduated from the Masachusetts Institute of Technology in 1875. For seven years he was Assistant Engineer of the Southern Pacific Ry. From 1882 to 1886 he was in private practice in Masachusetts, returning to the West in 1886 as Assistant Engineer on location and construction for the Southern Pacific Ry. In 1896 he was appointed Chief Assistant Engineer of the San Francisco & San Joaquin Valley Ry. Mr. Edes returned to the Southern Pacific Ry. in 1901 as Assistant Engineer on location and in 1905 was promoted to be District Engineer of Maintenance-of-way; and recently he was appointed Chief Engineer of the Northwestern Pacific R.R., a 500-mile railway system in California owned and operated jointly by the Southern Pacific and the Atchison, Topeka & Santa Fé Rys. As Locating Engineer for these railways Mr. Edes has had many years' experience in the survey and construction and of difficult mountain lines in California, Nevada, Oregon, Arizona and New Mexico. Lieut. Mears was born in Omaha, Neb., in 1878. His railway experience commenced in 1897 when he joined the engineer corps of the Great Northern Ry. under Mr. John F. Stevens, M. Am. Soc. C. E., later Chief Engineer of the Panama Canal, on the survey and construction of the Park Rapids extension and the Coon Creek cutoff, becoming later Assistant Engineer of the Kootnoi Valley R.R. He was commissioned an officer in the United States Army in 1899. He is recorded in the December, 1913, Army List as a "First Lieutenant of Cavalry." For a short time in 1905 he was Assistant Engineer with the Chicago, Rock Island & Pacific Ry. Since then he has been with the Isthmian Canal Commission as Assistant Engineer, Resident Engineer, Chief Engineer and General Superintendent of the Panama R.R. Mr. Riggs is a former officer of the Coast and Geodetic Survey and has had several years' experience on the survey of the Alaska boundary, which has recently been completed.

OBITUARY

ALFRED NOBLE

At three score years and ten a useful life
Has run its course. And as we think of him
The sorrow and the flowing tears of friends
Are turned to joy that such a one as he
Has lived and wrought. Here was a man who led
In building up, a mind endowed to see
And think and do in all the larger things,
A Captain leading men on Nature's fields
To win in building monuments of peace.
This Engineer has shattered Nature's works
To make the world a better dwelling place
For all of us. His life was gentle and
No thought of self within him dwelt. He won,
Scarce knowing why, the plaudits of the world.
Upon his monument let it be writ:
He was an Engineer. He was a Man.

W. L. SAUNDERS,
In the "Compresed Air Magazine."

Samuel E. Wilmer, Superintendent of the Water Department of Woodbury, N. J., since 1899, died May 1, aged 51 years. He is survived by a widow and one son.

Benjamin Franklin Warren, a civil engineer with the foreign sales department of the Tidewater Oil Co., died at his home in Brooklyn, N. Y., May 3. He was 68 years old. He was a graduate of the University of Pennsylvania and for many years was engaged in building oil pipe lines in Pennsylvania, Illinois and Indiana.

W. H. Brimson, former General Superintendent of the Baltimore & Ohio R.R., died Apr. '25, at his old home in Brainerd, Minn. He was Superintendent of the Duluth & Iron Range R.R. and the Northern Pacific Ry. before going to the Baltimore & Ohio R.R. in 1897. From 1904 to 1910 he was General Superintendent of the Baltimore & Ohio R.R.

Charles Francis, M. Am. Soc. C. E., died Apr. 29, at his home in Davenport, Iowa. Charles Francis was the son of James B. Francis, President of the American Society of Civil Engineers from 1880 to 1882, one of the most famous of American hydraulic engineers. Charles Francis was born in Lowell, Mass., Aug. 10, 1842. After completing a course in the local high school he entered Harvard University in 1860, but in 1861 he enlisted in the Union Army and served for a year at the front. Returning to college he graduated in 1864. After leaving college he spent some time in a Lowell machine shop, learning the trade of machinist, as a preliminary to following his father's profession as a hydraulic engineer. He was assistant to his father on the Turner Falls dam across the Connecticut River and the Provincetown, Mass., dike. He was in Chicago, Ill., for some time previous to the great fire of 1871; after that he went to Cali-

fornia where he was engaged in hydraulic mining operations for nine years. The following four years he was with the engineering staff of the Mexican Central R.R. in Mexico. In 1883 he returned to Lowell and was associated with his father until 1889. Mr. Francis went to Davenport in 1889 as Engineer in charge of construction of the Rock Island dam for the United States Government arsenal at Rock Island, Ill. After the completion of this work he continued to make Davenport his home, carrying on private practice as an engineer and contractor. For seven years he was a member of the State Board of Health, and he also served as Commissioner of Public Works of Davenport for two years.

Lawrence C. Brink, Assoc. M. Am. Soc. C. E., General Superintendent of the Pittsburgh Contracting Co., of New York City, died May 2, from typhoid fever, at his home in New York. He was born Sept. 18, 1868, at Frenchtown, N. J. Before entering college he served for a time with the engineer corps of the Pennsylvania R.R. After graduating from Lehigh University in 1894 he joined the engineering staff of the New York Central & Hudson River R.R. as a rodman. He remained with the New York Central until 1900, being engaged during that period mostly on New York City improvements. Mr. Brink became a member of the engineering corps of the Rapid Transit Commission in 1901, serving as Assistant Engineer under Alfred Craven, Division Engineer of the division from Park Ave. and 41st St., through 42d St. and north. While with the Rapid Transit Commission he made studies of the ventilation of the subway and he designed the louvers in use today. Early in 1906 he was appointed Superintendent for the United Engineering & Contracting Co., on the Pennsylvania R.R. tunnels crossing Manhattan under 32d and 33d Sts. From 1906 to 1907 he was Assistant Engineer, and from 1907 to 1910, Division Engineer in charge of the Wallkill division of the Northern Aqueduct Department of the Board of Water Supply, City of New York. Mr. Brink resigned his position with the Board of Water Supply in 1910 to become General Superintendent of the Pittsburgh Contracting Co., and under his supervision the company executed important construction work on the Catskill Aqueduct and the Passaic Valley trunk sewer. His long experience with the New York subways, the Pennsylvania R.R. and the Board of Water Supply tunnels placed him near the top of the profession in these lines of work. He had a large circle of friends to whom he endeared himself by his lovable and modest manner. He was a natural leader and was very popular, not only among his associates, but among his laborers, in whose welfare he ever took a warm interest. He is survived by a widow. [Contributed by Robert Ridgway and J. S. Langthorn, M's. Am. Soc. C. E.]

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN WATER-WORKS ASSOCIATION.
May 11-15. 34th Convention at Philadelphia, Penn. Secy., J. M. Diven, 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 18-21. 6th convention in Chicago, Ill. Secy., C. G. Hall, C. & E. I. R.R., 922 McCormick Bldg., Chicago, Ill.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 20-23. Annual meeting at Galveston, Tex. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

SIXTH NATIONAL CONFERENCE ON CITY PLANNING.
May 25-27. Toronto, Ont. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D Vought, 95 Liberty St., New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 26-29. Sixth convention at Rochester, N. Y. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 2-5. Annual convention at Baltimore, Md. Secy., Chas. W. Hunt, 220 W. 57th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 10-12. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 1112 Karpen Building, Chicago, Ill.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 11-13. Annual meeting at Toledo, Ohio. Secy., Frank E. Sanborn, Columbus, Ohio.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 15-17. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 1112 Karpen Building, Chicago, Ill.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
June 15-17. Annual convention at White Sulphur Springs, W. Va. Secy., F. D. Mitchell, Woolworth Building, New York City.

TRAIN DISPATCHERS' ASSOCIATION OF AMERICA.
June 16-19. Annual convention at Jacksonville, Fla. Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 16-19. Spring meeting at St. Paul and Minneapolis, Minn. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 17-20. Sixth semi-annual meeting at Troy, N. Y. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 23-26. Thirty-first annual convention at Detroit, Mich. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-26. Annual meeting at Princeton, N. J. Secy., Henry H. Norris, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 30-July 4. Seventeenth annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Montana Society of Engineers—In his address at the Great Falls meeting of the Society on Apr. 11, John H. Klippinger, the President, briefly reviewed the engineering work performed in Montana by the Great Northern Ry., during 1913. The branch lines were extended by over 100 miles of track. Work is now under way on two tunnels, one 900 ft. long, the other 3100 ft. long, at the summit of the Judith Mountain divide. The material to be removed from the long tunnel is a soft sandstone mixed with pockets of clay and coal veins and is of a general dry character. A station has been constructed at the eastern end of the tunnel for lighting and for running air compressors and drills. Power is obtained from the Great Falls Power Co. On the Shelby line near Collins two large steel bridges were erected to replace old wooden structures. One of these is across the Teton River and is 2600 ft. long and 130 ft. high. The other is across Muddy River and is 900 ft. long and 100 ft. high. Both of these bridges are of the girder-and-tower type on concrete pedestals. On the towers the girders are 36 ft. long and between the towers 54 ft. long. These bridges were erected at one side of the old structures, making a slight change in line necessary at each end.

During the summer about 800 lin.ft. of reinforced-concrete snow-sheds were constructed on the main line between Highgate and Java, on the west side of the summit of the Rocky Mountains. This type of snow-shed is being constructed in both the Rocky and the Cascade Mountains. The back wall of the shed, up against the mountainside, is constructed of reinforced concrete, the top of the wall being 30 ft. above the rail. Concrete pedestals are put in between the tracks and outside the outer track, to support the roof posts. The roof is constructed of 12x12-in. timbers.

A number of old trestles were replaced by concrete trestle-and-slab bridges. The flooring of these bridges is carried on concrete piles spaced on 16-ft. centers. The decks are built of reinforced-concrete slabs. Gravel is placed on the slabs to a thickness of 1 ft. under the ties. On the line between Whitefish and Rexford, nine Howe-truss bridges were replaced by steel girders on concrete foundations, and on the line between Great Falls and Butte, two other such bridges were thus replaced. Three modern passenger depots have been erected; one at Butte, one at Helena, and one at Lewistown. These buildings are of concrete and brick, with white-enamel brick interior finish and marble floors.

International Irrigation Congress—The 21st annual meeting of the Congress will be held in Calgary, Oct. 5-9. The headquarters is at 3 Board of Trade Building, Calgary, Alta.

National Foreign Trade Convention—The call for a national trade convention, to be held in Washington, D. C., May 27-28, under the auspices of the American Manufacturers' Exports Association, the American-Asiatic Association, and the Pan-American Society, results from a realization that the foreign trade of the United States is now at a critical point. It is intended to promulgate a systematic foreign trade policy.

The importance of foreign trade to the railways will be the subject of a paper by Fairbanks Harrison, President of the Southern Ry. H. G. Herget, President of the Illinois Manufacturers' Association, will treat of the situation in the Middle West. Alva B. Johnson, President of the Baldwin Locomotive Co., will speak of the possibilities of stimulating American exports by a larger use of raw materials from partially developed countries. In order that the Convention may be a practical business men's discussion, yielding definite results, all papers will be prepared in advance and distributed to the delegates before the meeting. Headquarters at the present time is at 66 Broadway, New York City.